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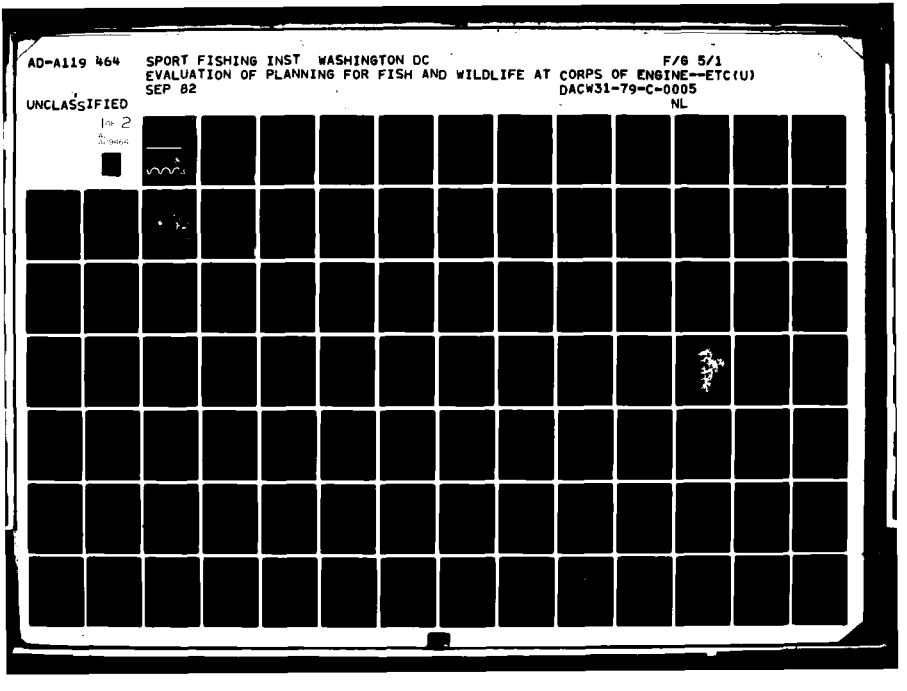
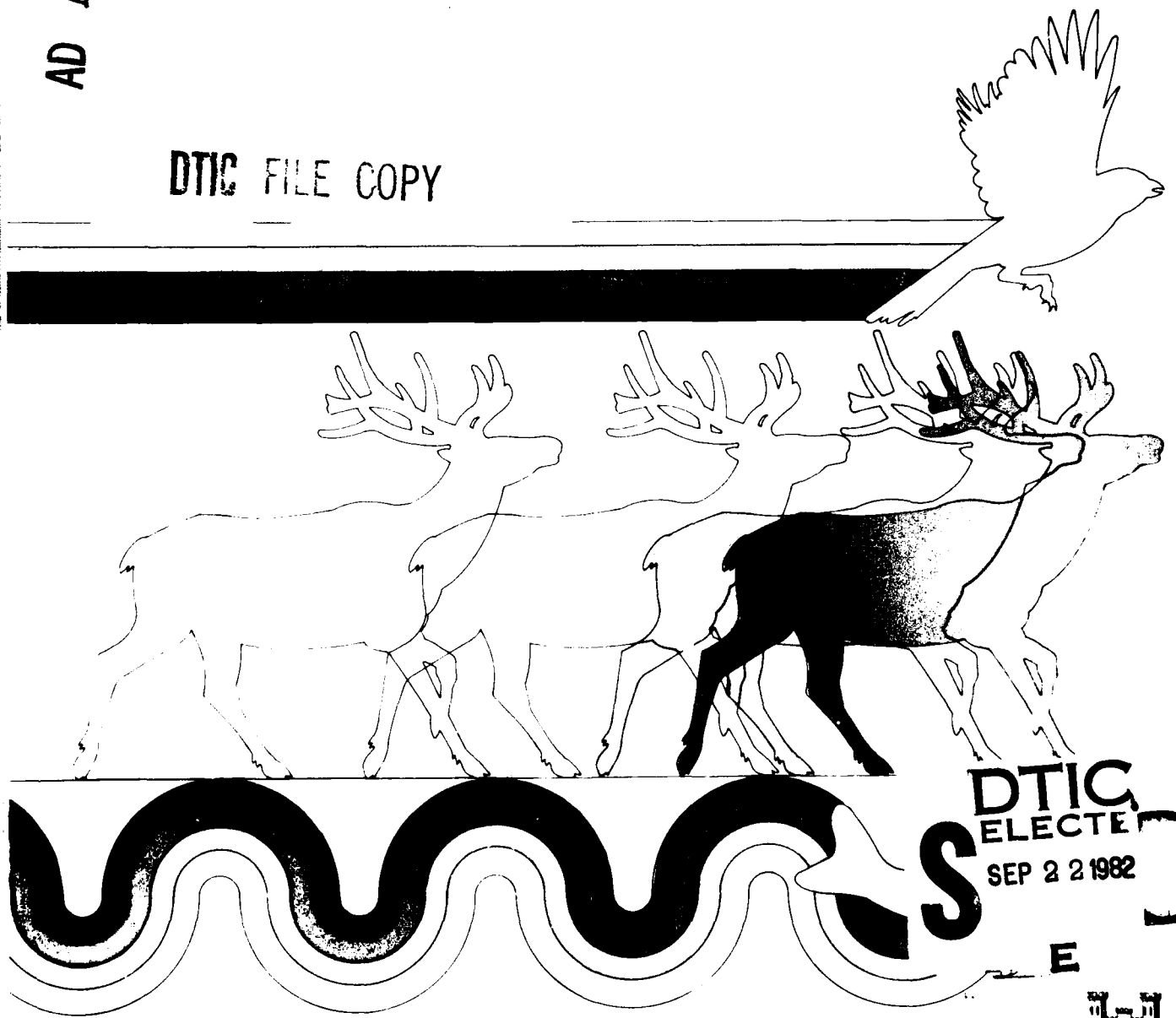


Evaluation of Planning for Fish & Wildlife

Eufaula Lake Project
September 1982



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Planning evaluation	Water quality studies
Planning recommendation	Eufaula, Oklahoma

20. ABSTRACT (Continue on reverse side if necessary and identify by block number)

Eufaula Dam is located in eastern Oklahoma at river mile 27 on the Canadian River approximately 19 km (12 mi) east of Eufaula and 50 km (31 mi) south of Muskogee, Oklahoma. Eufaula Lake, the largest body of water in Oklahoma, extends into McIntosh, Haskell, Pittsburg and Okmulgee counties, Oklahoma.

Construction of the dam was initiated in December, 1956, and final closure was made for flood control in February, 1964. At full power pool, Eufaula Lake inundates 41,360 ha (102,200 ac) extending upstream from the dam on the

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Candian River and three tributary streams (North Canadian River, Deep Fork River and Gaines Creek). A total of 74,167 ha (183,264 ac) were acquired for the project. Project lands acquired above the power pool total some 20,715 ha (51,187 ac) extending in a narrow band around the highly convoluted 965 km (600 mi) lake shoreline. Much of the land in the vicinity of the lake is devoted to agriculture, particularly livestock production, or has been subdivided for home sites for year-round or seasonal occupancy.

Pre-project wildlife habitat quality was considered poor and wildlife population minimal on most of the areas as a result of severe overgrazing fostered by landowners prior to purchase by the CE. The 483 km (300 mi) of stream located within the project impact area supported only meager fish communities as a result of unstable bottom strata, turbidity and chronic pollution from oil field brine wastes, mining and domestic sewage. As a result of the restrictive land acquisition policy adopted by the CE for the Eufaula Lake project, post-impoundment wildlife habitat is extremely limited and poorly situated for efficient management. Much of the project land available for wildlife habitat development is situated in a narrow, often discontinuous, strips around the lake periphery.

Other than submission of a preliminary report in January, 1950, the FWS did not provide a formal evaluation nor offer recommendations for mitigating adverse impacts on fish and wildlife resources anticipated by the Eufaula Lake project until submission of the November 15, 1962 planning report, more than six years after the start of project construction and less than two years before completion. This unseemly and lengthy hiatus following initiation of project construction and the submission of the November, 1962 FWS report apparently reduced the cogency of the FWS recommendations pertinent to fish and wildlife resource mitigation and/or enhancement.

It was evident that the CE did not give serious consideration of implementing any of the November 15, 1962 FWS report recommendations that entailed monetary expenditures and/or substantial alteration of previously established project design parameters. The CE failed to implement the FWS recommendation for the purchase of lands outside the established purchase boundary specifically for wildlife resource mitigation. Only a narrow strip of land peripheral to the lake was obtained. These holding offered only minimal potential for wildlife resource development. Other similar examples include the failure of the CE to consider FWS recommendations for provision of an instantaneous minimum flow below the project, the failure to develop a fishing platform in the tailwater, and the failure to provide funding for fencing and initial development of project lands subsequently leased to the ODWC and wildlife management areas.

On the other hand, the CE implemented FWS recommendations such as provision of basic hunter and angler access facilities, reservoir zoning, and negotiation of lease agreements to provide for ODWC management of project lands acquired incidental to other project objectives. A license agreement, executed initially on January 1, 1973 and amended January 1, 1981, provide the ODWC with six wildlife management units with a total area of 19,165 ha (48,469 ac) including 8,481 ha (20,956 ac) of terrestrial habitat and 11,235 ha (27,513 ac) of water area. These areas subsequently were managed intensively by the ODWC for upland game and waterfowl.

The accuracy of FWS planning report predictions of post-impoundment hunter and angler man-day use proved highly variable. Post-impoundment hunting man-day use for white-tailed deer was much greater than predicted. Hunting effort

(CONTINUED ON NEXT PAGE)

for upland game and waterfowl were reasonably on target. Based on post-impoundment hunting man-day use estimates developed by ODWC for licensed lands, it seems likely that full implementation of the mitigation plan proposed by the FWS in the November 15, 1962 planning report would have substantially mitigated predicted project occasioned wildlife resource losses.

The FWS considerably under-estimated the actual extent of the post-impoundment recreational fishery, both in Eufaula Lake and the Canadian River tail-water below the dam. Post-impoundment recreational angling man-day use documented for the total project impact area was more than 2.5 times greater than predicted by the FWS. FWS predictions of the extent of the post-impoundment Eufaula Lake commercial fishery, on the other hand, were considerably exagerated.

Overall, the construction of the Eufaula Lake project greatly increased recreational angling opportunity within the area of project influence. Documented post-impoundment angling man-day use at Eufaula Lake and tailwater (316,508 man-days) was more than 2,100 percent greater than the FWS estimate of 14,000 angling man-days per year without the project.

STUDY TO EVALUATE THE ADEQUACY AND PREDICTIVE VALUE OF FISH AND WILDLIFE PLANNING RECOMMENDATIONS AT CORPS OF ENGINEERS RESERVOIR PROJECTS

INDIVIDUAL RESERVOIR PROJECT EVALUATION REPORTS

THE EUFAULA LAKE PROJECT

Conducted for Office, Chief of Engineers, U.S. Army

By Sport Fishing Institute, Washington, D.C.

Under Contract No. DACW31-79-C-0005

PREFACE

This document was prepared by staff of the Sport Fishing Institute for the U.S. Army Corps of Engineers (CE) under contract number DACW31-79-C-00005. The contract requires the compilation and comparison of pre- and post-construction data treating fish and wildlife for twenty separate CE water development projects. This report presents the findings for one of the twenty individual project evaluations.

Upon completion of the full series of twenty separate studies, a final report will be prepared which will contain an analysis of the validity of the predictive procedures used in fish and wildlife planning, and will contain recommendations for improving fish and wildlife planning.

Evaluation of the fish and wildlife resources of the Eufaula Lake project would not have been possible without the assistance and cooperation of many individuals. Oklahoma Department of Wildlife Conservation personnel Dr. Charles Wallace, Dr. Harold Nemminga, Greg Summers, J. Fred Hietman, Greg Wigtail and Ken Bankwitz assisted with the design and execution of post-project fishery resource inventory aspects and Byron Mosher, Greg Duffy and Bill Scherman furnished essential information concerning wildlife resources.

Buell Atkins, Jim Randolph and other staff members of the Environmental Resources Branch, Tulsa District, U.S. Army Corps of Engineers furnished pertinent project planning documents. Other Corps personnel located at the

Eufaula Lake project office in Stigler, Oklahoma, (Ben Carroll and Jim Holderfield) furnished vital post-impoundment use statistics and other information concerning wildlife population density.

Mr. Sidney Wilkerson and Ken Frazier at the Oklahoma Office of the U.S. Fish and Wildlife Service provided all available pre-construction planning documents and copies of appropriate correspondence.

Murray Walton, South Central Field Representative, Wildlife Management Institute accompanied project personnel on a inspection tour of the Eufaula Lake project and reviewed the wildlife-related (non-fish) section of the draft manuscript.

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SPORT FISHING INSTITUTE

PROJECT PERSONNEL

Robert Martin (Project Leader)

Norville Prosser (Assistant Project Leader)

Gilbert Rodanski (Contractor's Representavies)

Naomi Higgins (Project Secretary)

CONSULTANT'S REVIEW

Professional terrestrial wildlife consultative services were provided by the staff of the Wildlife Management Institute (WMI). Project personnel were accompanied by a WMI staff specialist during field reconnaissance and on on-site discussions. The terrestrial wildlife portion of the prepared evaluative manuscript was reviewed and evaluated by WMI.

INTRODUCTION

Location

Eufaula Dam is located in eastern Oklahoma at river mile 27 on the Canadian River approximately 19 km (12 mi) east of Eufaula and 50 km (31 mi) south of Muskogee, Oklahoma (1). Eufaula Lake, the largest body of water in Oklahoma, extends into McIntosh, Haskell, Pittsburg, Okmulgee counties, Oklahoma at average power pool elevation (Figure I). The southernmost extremity of the lake is in the vicinity of MacAlester, Oklahoma. The northwest extremity is within 8 km (5 mi) of Henryetta and 24 km (15 mi) of Okmulgee, Oklahoma. Major cities within 161 km (100 mi) of the lake include Tulsa and Oklahoma City, Oklahoma and Fort Smith, Arkansas. East-west access provided by Interstate Highway 40, to the north and Highway 270 to the south of the lake. The Indian Nation Turnpike follows a north-south direction, linking with U.S. Highway 75 along the western lake perimeter. U.S. Highway No. 69 traverses the lake in a northeast-southwesterly direction and intersects the lake at several locations.

Authorization

Eufaula Dam and Reservoir was authorized by the River and Harbor Act approved July 24, 1946 (Public Law No. 525, 79th Congress, 2nd Session), for flood control, hydropower production, navigation, water supply and fish and wildlife.

Authority for the administration of lands and water areas is contained in Section 4 of the Flood Control Act approved December 22, 1944 (58

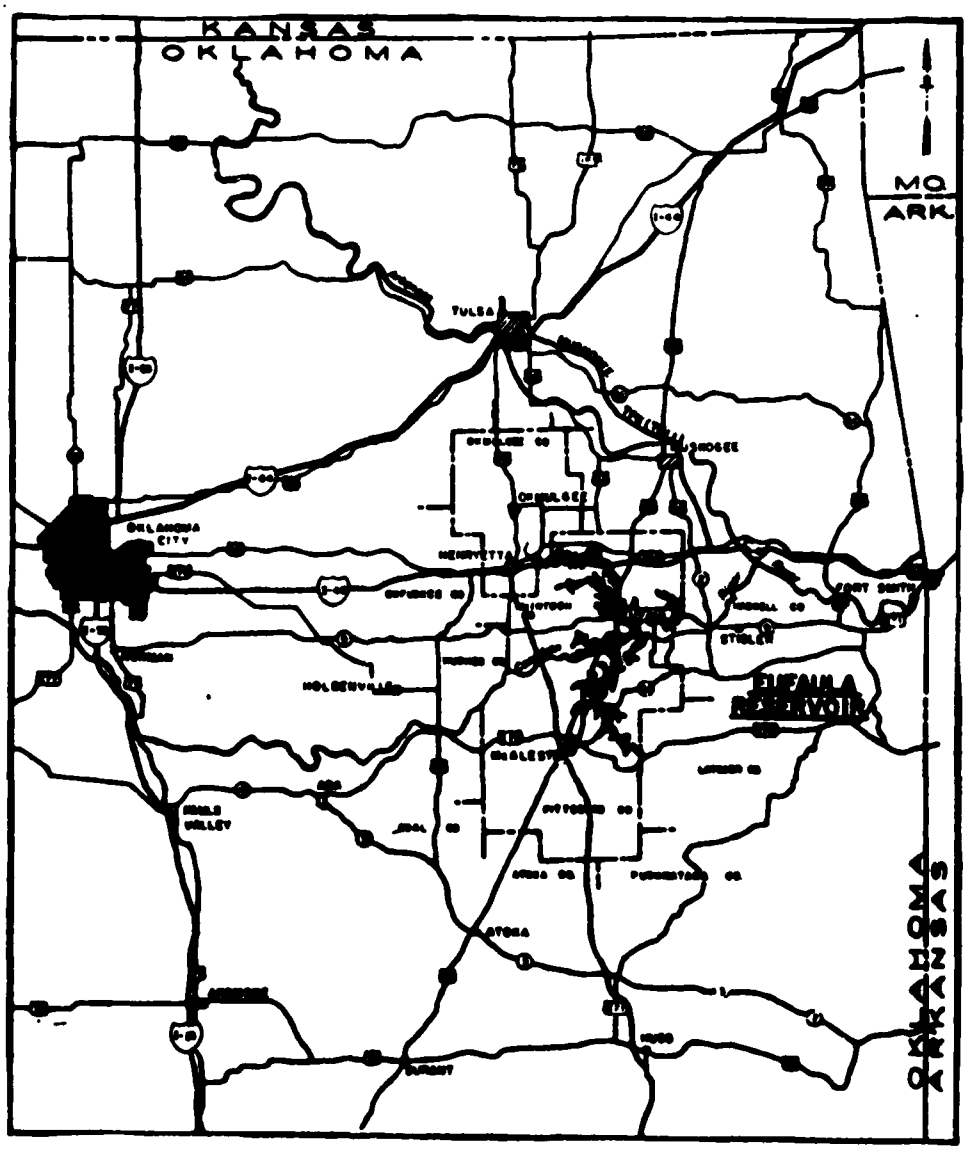


Figure 1. Location map -- Eufaula Lake Project.

Stat. 889), and by Section 4 of the Flood Control Act of 1946 (60 Stat. 642) as further amended by Section 209 of the Flood Control Act of 1954 (2). Development at the lake is governed by provisions of the Federal Water Project Recreation Act of 1965 (PL 89-72).

Physical Features

Construction of the dam was initiated in December, 1956, and final closure was made for flood control in February, 1964. The dam is a combination concrete and earthen structure approximately 97.5 m (114 ft) above the main channel of the Canadian River. The outlet works consists of a 158 m (520 ft) long concrete spillway with eleven 12 m by 9.7 m (40 ft by 32 ft) tainter gates separated by 2.4 m (8 ft) wide piers and a single 1.7 m by 2.1 m (5.7 ft by 7 ft) low flow sluice. The powerhouse intake consists of three 6.7 m (22 ft) diameter penstocks, one to each of three 30,000 kilowatt generators.

The lake covers approximately 58,155 ha (143,700 ac) at the top of the flood control pool, elevation 182 m (597 ft) mean sea level (msl). The power pool fluctuates between a maximum at elevation 178 m (585 ft) and a minimum at elevation 172 m (565 ft) msl (3). At full power pool, Eufaula Lake inundates 41,360 ha (102,200 ac) extending upstream from the dam on the Canadian River and three tributary streams (North Canadian River, Deep Fork River and Gaines Creek).

A total of 74,167 ha (183,264 ac) were acquired for the project, including 62,076 ha (153,387 ac) by fee simple title and the remaining 12,091 ha (29,877 ac) by flowage easement (Table 1). Project lands acquired

Table 1. -- Eufaula Lake Project. Summary of pertinent physical characteristics.

Elevation, msl [m (ft)]		
Top of dam	186	(612)
Original stream bed	152	(498)
Top of flood pool	182	(597)
5-year flood frequency	181	(595)
Top of power pool	178	(585)
Bottom of power pool	172	(565)
Maximum depth at top of power pool	27	(87)
Average depth at top of power pool	7	(23)
Area [ha (ac)]		
Top of flood pool	58,155	(143,700)
5-year flood pool	55,230	(138,200)
Top of power pool	41,360	(102,200)
Bottom of power pool	19,426	(48,000)
Storage capacity [m^3 (ac-ft)]		
For flood control	$1.81 \times 10^9 m^3$	(1,468,000)
For power production	$1.81 \times 10^9 m^3$	(1,465,000)
Sediment storage	$1.11 \times 10^9 m^3$	(897,000)
Area purchased [ha (ac)]		
Fee simple title	62,076	(153,387)
Flowage easement	12,091	(29,877)
Total	74,167	(183,264)
Shoreline length [km (mi)]		
Top of power pool	965	(600)
Drainage area [sq km (sq mi)]	123,082	(47,522)
Average annual precipitation [cm (in)]	95	(37.4)
Length of growing season (No. days)		(215)

above the power pool total some 20,715 ha (51,187 ac) extending in a narrow band around the highly convoluted 965 km (600 mi) lake shoreline. The Oklahoma Department of Wildlife Conservation (ODWC) was granted a license by the Corps of Engineers (CE) on January 5, 1973, to manage fish and wildlife resources on a total of 12,899 ha (31,873 ac) of land and water area which included 7,463 ha (18,440 ac) of land and 5,436 ha (13,433 ac) of water (4).

Area Description

The terrain in the Eufaula Lake region consists of flat to gently rolling valley lands bordered by steeply rolling to semi-mountainous areas. The major river valleys are generally broad, but narrow, restricted reaches occur in the more rugged hilly areas. The valleys of the tributaries are V-shaped and narrow.

Much of the land in the vicinity of the lake is devoted to agriculture, particularly livestock production, or has been subdivided for home sites for year-round and seasonal occupancy. The limited wooded areas near the lake are primarily mixed bottom land hardwoods (cottonwood, willow, sycamore ash, elm, hackberry, pecan, and flood-tolerant oaks); and upland hardwoods such as post oak, red oak, white oak, blackjack oak and hickory interspersed with short leaf pine. Trees found within the flood-tolerant areas which can best withstand inundation are cypress, cottonwood, river birch, sycamore, hackberry, ash, and honey locust.

The mean annual temperature for the Eufaula Lake region is 16.8°C (62°F). Average annual rainfall is 94 cm (37.4 in). In general, the spring is

the wettest season of the year, 33 percent of the yearly average rain may be expected to fall during these months; winter is the driest, when the lake region may expect to receive only about 14 percent of the yearly average rainfall. The average length of the growing season is 215 days, extending form Marcy 29 to October 30.

The four-county area in which the project is located is heavy to sparsely populated. 1980 census figures list a total population of 102,300. Population projections of the four-county impact area indicate continued growth for the region.

WILDLIFE RESULTS AND DISCUSSION

Wildlife Resources -- Pre-impoundment Predictions

1950 FWS Report

The first reference to fish and wildlife planning for the Eufaula Lake project was found in a Fish and Wildlife Service publication titled "A Preliminary Evaluation Report on Fish and Wildlife Resources in Relation to the Eufaula, Onapa and Canadian Reservoir Projects, Canadian River, Arkansas River Basin, Oklahoma "(5). This FWS report, dated January, 1950, was initiated at the request of the District Engineer, Tulsa District, CE in 1948. The report provided a comparison of the impacts on fish and wildlife resources predicted from construction of a single large dam and reservoir located on the Canadian River (the Eufaula Lake project) and an alternative CE proposal involving the construction of two smaller reservoirs to be located on two major tributaries to the Canadian River, the South Canadian River (Canadian Reservoir project) and the North Canadian River (Onapa Reservoir project).

A total of 82,559 ha (204,000 ac) of terrestrial habitat was expected to be impacted by the single reservoir Eufaula Lake project as compared to a total of 75,487 ha (186,525 ac) impacted by development of the alternative two-reservoir system (Canadian and Onapa reservoirs). The project impact area designated by the FWS for the Eufaula Lake project included some 45,650 ha (112,000 ac) below the average annual maximum reservoir pool which would be permanently inundated and 36,909 ha

(91,200 ac) of peripheral lands which were expected to undergo changes in use patterns as a result of project development (Table 2). Comparable values for the combined Canadian and Onapa reservoir system included 32,497 ha (80,300 ac) which would be permanently inundated plus an additional 42,989 ha (106,225 ac) of peripheral lands.

All three proposed reservoir sites were in close proximity with similar wildlife resources consisting primarily of upland game species, furbearers, and waterfowl. No significant big game populations were present in the vicinity of any of the proposed sites. The status of the upland game species within the general project region was described as follows (5):

> Upland game in the region which would be affected by the project includes mourning doves, bobwhite quails, gray squirrels, fox squirrels, and cottontail rabbits. Mourning doves use the project area in moderate numbers for nesting and for feeding during migration. The entire project area supports a good bobwhite quail population. The mixture of cultivated areas, pasture, and woods with the many "edges" of cover types provides extensive food and shelter for these birds. Hunting pressure is moderate considering the area as a whole although certain localities are heavily hunted.
>
> The timbered portions of the project area contain a moderate squirrel population. The bottomland timber supports the greatest number per acre with grey squirrels predominating. Upland timber generally has a less dense population, and fox squirrels are the most numerous. The hunting season lasts over seven months and hunting pressure is heavy.
>
> Cottontail rabbits are fairly abundant throughout the project area and furnish a moderate amount of sport. Considerable numbers of these animals are killed incidental to quail and squirrel hunting.

Table 2. -- Eufaula Project. Comparison of terrestrial habitat affected by CE development of single large reservoir on the Canadian River (Eufaula Reservoir) with an alternative CE proposal for the construction of two smaller reservoirs (the Onapa reservoir on the South Canadian River and the Canadian Reservoir on the North Canadian River). Data extracted from the January, 1950 FWS report (5)

	Eufaula reservoir project	Canadian[1] and Onapa project
Reservoir area [ha (ac)]		
Maximum flood pool	56,696 (140,100)	34,440 (85,100)
Average annual maximum pool	45,650 (112,800)	32,497 (80,300)
Average annual minimum pool	36,059 (89,100)	19,142 (47,300)
Reservoir water level fluctuation[2]		
Vertical [m (ft)]	2.3 (7.6)	4.9 (16.2)
Area [ha (ac)]	9,591 (23,700)	13,355 (33,000)
Timberland destroyed [ha (ac)]	13,355 (33,000)	9,614 (23,755)
Block perimeter lands [ha (ac)][3]	36,909 (91,200)	42,989 (106,225)
Total project impact area [ha (ac)][4]	82,559 (204,000)	75,487 (186,525)

1/ Combined values for the Canadian and Onapa reservoirs.
2/ Fluctuation between average annual maximum and minimum pools.
3/ Contiguous lands located above the average annual maximum pool expected to experience land use changes or otherwise be impacted by project construction.
4/ Consists of block perimeter lands plus lands flooded below the average annual maximum pool.

Although furbearers were described as relatively abundant within the area, the January, 1950 FWS report considered them of little monetary value, viz:

> Fur animal resources within the project area, including the three reservoir sites, are of limited value. Striped skunks, opossums, and raccoons are common on all project lands. Minks are moderately abundant and muskrats are scarce on all of the larger streams or rivers of the project area. Little trapping for muskrats and raccoons and low prices for their pelts result in the annual value of these two animals being insignificant.

Waterfowl use within the general project area was considered to be moderate, (op. cit.):

> Waterfowl - Waterfowl would use the project reservoirs to a moderate extent during migration. The area is adjacent to a major migration route down the valley of the Arkansas River used by large numbers of mallards, pintails, blue-winged teals, baldpates, shovellers, gadwalls, lesser scaups, redheads, canvasbacks, and ruddy ducks. Common Canada geese, white-fronted geese, and lesser snow geese would also use the water areas of the project. Little nesting activity would be anticipated at any of the reservoirs, except for wood ducks.

Project construction was expected to decrease wildlife resource values at the Eufaula Lake project by some $19,000 (from a pre-project value of $30,000 to a post-project value of $11,000). Wildlife resource values at the Canadian Reservoir project also were expected to decline severly (by $6,600), decreasing from a pre-project value of $11,000 to a post-project value of only $4,400.

However, due to an offsetting $6,000 increase in the predicted post-

impoundment wildlife value at Onapa Reservoir (increasing from a pre-project value of $15,000 to $21,000), construction of the combined Canadian/Onapa reservoir system was expected to result in only a marginal loss ($600) in project wildlife resource values (Table 3).

The predicted post-impoundment increase in wildlife resource values associated with the development of the Onapa project was attributed primarily to an increase expected in waterfowl utilization of the reservoir (op. cit.):

> The sediment pool area of Onapa Reservoir would be attractive to waterfowl. The pool would create large, marshy areas of emergent vegetation which would provide food and cover of waterfowl, and adjacent agricultural areas would provide additional food. This would particularly apply to the Deep Fork arm.

Without exception, the January, 1950 FWS report indicated a diminution of upland game species at all three reservoir sites as a result of permanent habitat loss due to impoundment and to land use changes anticipated peripheral to the reservoirs.

Although the specific term "in-kind replacement" was not used, the January, 1950 FWS report emphasized that every effort should be made to maintain the integrity of each of the various wildlife groups, viz:

> The proposed development of the Eufaula site would result in an annual loss of about $22,000 in upland game resources. The development of the Onapa and Canadian sites would cause a reduction of about $17,000 in the annual harvest of upland game. Other wildlife groups would be benefitted by the proposed projects, but it is important that one resource should not be sacrificed for the gain of another.

Table 3. -- Eufaula Lake Project. Comparison of with and without the project wildlife resource values assessed in the January, 1950 FWS report for the Canadian and Onapa Reservoir system with the Eufaula Reservoir project

	Canadian project	Onapa project	Subtotal	Eufaula project Amount	Eufaula project Difference*
Impact area [ha (ac)]	30,268 (74,790)	45,219 (111,735)	75,487 (186,525)	82,559 (204,000)	+7,072 +17,475
Monetary value($)					
Without project					
Total $'s	11,000	15,000	26,000	30,000	+4,000
$/ha (ac)	0.36 (0.15)	0.33 0.13	34 0.14	0.36 0.15	+0.02 +0.01
With project					
Total $'s	4,400	21,000	25,400	11,000	-14,400
Net value($)	-6,600	+6,000	-600	-19,000	-18,400

*Difference in values between the Eufaula project and the combined Onapa and Canadian Reservoir system.

Recommendations offered in the January, 1950 FWS report to provide partial mitigation of anticipated wildlife resource losses were as follows:

(a) In planning for public use of the project, provision was made for free and ready access adequate for the needs of anglers and hunters.

(b) Project lands be acquired in fee simple.

(c) Project plans include provision for control of existing and potential pollution in the reservoir and other streams of the project area.

(d) Fish and wildlife inherent in or resulting from construction of the project remain under the jurisdiction of the State of Oklahoma.

In addition, the report suggested that agricultural leases, granted at appropriate locations, would be beneficial for upland game species, viz:

> The leasing of the fertile sites, most suitable for cultivation and less likely to be inundated, would be of much benefit to upland game. If these leases are so located as to provide a suitable mixture of timber, brush, pasture, and cultivated areas, the upland game would not suffer the losses shown in this report. Much of the losses shown would be caused by the reduction or elimination of small grains and legumes and the increase in timber and grazing land.

The possibility of establishing a National Wildlife Refuge in conjunction with project construction was also discussed, viz:

> National Wildlife Refuge Possibilities - Either the single Eufaula Reservoir or the Onapa Reservoir of the Canadian-Onapa plan of development would provide opportunities for the establishment of a National Wildlife Refuge. The location, size, creation of large bodies of water in the form of arms of the lake more or less isolated from the main body of the lake and from centers of human populations, and other factors would be favorable insofar as refuge requirements are concerned. A refuge in the vicinity of the project area has previously been determined

> by the U.S. Fish and Wildlife Service to be desirable for the National Waterfowl Refuge program. Doubt exists that Canadian Reservoir would be suitable for a National Waterfowl Refuge.

1962 FWS report

The November 15, 1962 FWS letter-report, addressed to the District Engineer, Corps of Engineer, U.S. Army, Tulsa, Oklahoma, constituted the final FWS assessment of fish and wildlife resources associated with the construction of the Eufaula Lake project (6). The report was reviewed and endorsed by the ODWC (7).

Based on planning data provided by the CE, the FWS estimated that a total of 79,625 ha (196,750 ac) would be acquired by the CE for the project including 69,170 ha (172,250 ac) to be purchased in fee simple and 9,915 ha (24,500 ac) in flowage easements. For purposes of wildlife resources evaluation, the FWS included an additional 5,666 ha (14,000 ac) of riparian habitat below the Eufaula Dam which was expected to experience post-impoundment changes in land use as a result of additional flood protection provided by the project. Including the riparian habitat below the dam, the total project impact area amounted to 85,291 ha (21,750 ac).

Pre-project wildlife resources and hunting pressure were described in the November, 1962 FWS report as follows:

> Important game animals in the Eufaula Project area include white-tailed deer, bobwhites, fox squirrels, gray squirrels, cottontails, swamp rabbits, raccoons, and mourning doves. Also present, but of less importance, are red foxes, gray foxes, bobcats, red

> wolves and wood cocks. Waterfowl using the area include mallards, blue-winged teal, pintails, shovelers, gadwalls, baldpates, and wood ducks. Diving ducks and geese are infrequent visitors to the area.
>
> Wildlife habitat lying within the reservoir site and on the lands to be protected from flooding downstream from the dam is considered to be of good quality. The project lies in an area of steeply rolling forested hills which mark the eastern extremity of the Central Low-land Province. Flood plain bottom lands define the western limits of the Arkansas Valley Section of the Ouachita Province. The uncultivated uplands have timbered areas of post oaks and blackjack oaks with scattered stands of woody vegetation interspersed with forbs and grasses. Bottom lands have typical luxuriant streambank vegetation with occasional open areas on either side of the stream.

Contrary to the January, 1950 FWS report, which indicated that white-tailed deer were absent from the project area, the November, 1962 FWS report stated that white-tailed deer were present in small numbers throughout the project area, viz:

> White-tailed deer are the only big-game animals in the project area. They are found in small, widely scattered numbers throughout the project area. Their numbers are expected to increase only slightly over the period of analysis without-the-project. Browse and mast available to deer are limited to volume as a result of overgrazing by livestock and clearing of land for agriculture. Projected over the period of analysis without-the-project, it is estimated that lands within the reservoir area would provide about 200 man-days of deer hunting annually.

Observations concerning upland game, waterfowl, or furbearer populations were similar to those reported in the January, 1950 FWS report, viz:

> Upland game habitat is fair to good in both quantity and quality over most of the project area. Bottom lands maintain good small game habitat because of the diversification of cover types and the favorable

> ratio of croplands to cover. Bobwhites, fox squirrels, and gray squirrels provide the most hunting. Cottontails and mourning doves provide a lesser amount of hunting. It is anticipated that upland game population will maintain their present densities and may increase slightly in the area adjacent to agricultural croplands. Raccoon and opossum hunting with hounds is a favored form of recreation in the area. Without the project, the area would support about 10,800 man-days of upland game hunting annually.
>
> Waterfowl habitat involves the 300 miles of streams and the bottom lands that will be affected by the project, as well as several stock ponds. There are no overflow lakes of importance in the area. The shortage of food along the streams precludes waterfowl from remaining in the area for any length of time during migration. When flood waters coincide with migration periods, waterfowl use is increased materially. Waterfowl hunting is considered poor although considerable numbers of waterfowl are known to pass through the project area annually. Without the project, there would be about 560 man-days of waterfowl hunting annually.
>
> Fur animal species commonly found in the project area are skunk, opossum, raccoon, and mink. Less common species are beaver, muskrat, weasel, foxes, coyote and bobcat. These fur animals presently are of minor importance due to the low pelt value, or, in the case of mink, their scarcity. Most of the limited take is incidental to sport hunting, or on a part-time basis. Fur animal values are not expected to increase significantly during the period of analysis without the project.

With the project in place, the FWS predicted that substantial losses of upland game and big game habitat would occur. Approximately 63,538 ha (157,000 ac), amounting to some 75 percent of the total project impact area of 85,291 ha (210,750 ac), of habitat would be lost as a result of impoundment or otherwise adversely affected, viz:

> Big game and upland game habitat in the project area will be severely reduced as the result of construction

> and operation of Eufaula Reservoir. About 102,500 acres of habitat will be lost through inundation at top of the power pool and 40,500 acres above the elevation will be intermittently flooded. There will be 14,000 acres of habitat in the downstream flood plain that will receive flood protection thereby causing additional changes in habitat.

An increase in waterfowl habitat was expected with impoundment of Eufaula Lake, but the quality of the lake habitat for waterfowl was expected to be low, viz:

> It is anticipated that Eufaula Reservoir will receive moderate waterfowl use even though most of the reservoir will consist of low quality waterfowl habitat. The project area is located near a main waterfowl flight line through Oklahoma and is about 200 miles northeast of two national wildlife refuges on Lake Texoma. Due to its large water area, the reservoir will be used by most species of waterfowl, especially diving ducks. It is expected that moderate use of the area will be made by wintering ducks and geese provided there is adequate food and sanctuary on or adjacent to the reservoir.

Loss of big game and upland game hunting opportunity with the project in place also was expected to be severe (Table 4). Only an insignificant number of man-days of hunting was predicted for white-tailed deer if the project was constructed (op. cit.), viz:

> White-tailed deer habitat will be reduced by the project due to inundation within the reservoir site and from habitat changes in the area below the dam. Deer will be taken occasionally, and the number of man-days of hunting that can be sustained annually will be insignificant.

Hunting opportunity for upland game species, was expected to decline by

Table 4. -- Eufaula Lake Project. Comparison of November, 1962 FWS report predictions of annual hunting man-day use predicted over an assumed 50-year project life with and without the project in place (6)

	Man-day use			
	Without project No.	With the project No.	Loss or gain No.	%
White-tailed deer	200	0.0*	-200	-100
Upland game	10,800	1,700	-9,100	-84
Subtotal	11,000	1,700	-9,300	-84
Waterfowl	560	2,500	+1,940	+346
Total	11,560	4,200	-7,360	-64

*Insignificant

some 84 percent (from 10,800 hunting man-days per year without the project to only 1,700 hunting man-days per year with the project in place) (op. cit.), viz:

> Upland game habitat will be adversely affected by the project. Approximately 102,500 acres will be inundated at top of power pool and the value of an additional 40,500 acres to top of flood control pool will be reduced according to the severity and frequency of inundation and human disturbance. Upland game take will be drastically reduced. Gray squirrel and cottontail habitat will be most severely affected, while bobwhite, fox squirrel, and mourning dove habitat will be restricted to a small portion of the area within the flood control pool. With the project, the area can be expected to support about 1,700 man-days of upland game hunting annually.

Contrary to the loss of hunting opportunity for upland game species and white-tailed deer, hunting man-day use for waterfowl was expected to increase over four-fold after impoundment (2,500 man-days per year compared to only 560 trips without the project), viz:

> Waterfowl hunting on Eufaula Reservoir will be largely dependent on the amount of available waterfowl food in the vicinity of the reservoir, the protection which the birds receive, and the availability of good hunting sites. Assuming that the above conditions are favorable, it is estimated that with the project approximately 2,500 man-days of waterfowl hunting will be carried out annually.

Although not expressed quantitatively, the November, 1962 FWS report predicted that furbearers would be affected adversely by the project, viz:

> Several factors deleterious to the production of fur animals will be initiated with the project. The inundation of habitat, additional clearing along the flood plain downstream from the dam, and fluctuation of the water levels in the reservoir will result in

a reduction in numbers of skunks, opossums, and raccoons in the project area.

The November, 1962 FWS report presented several appropriate recommendations designed to compensate for the predicted loss of hunting opportunity for white-tailed deer and upland game species within the project impact area, viz:

(1) That public access be assured by maintaining those State and county roads within the project area as designated by the Oklahoma Department of Wildlife Conservation.

(2) That a zoning plan be developed for Eufaula Reservoir to insure that adequate areas will be available for fishing and hunting and that the parties involved in developing the reservoir zoning plan include the Oklahoma Department of Wildlife Conservation.

(3) That in accordance with the resolution of the Oklahoma Wildlife Conservation Commission dated August 20, 1962, approximately 12,841 acres of land be acquired in fee title at project cost and, together with other project-acquired land as shown on Plate I, be made available to the Oklahoma Department of Wildlife Conservation for fish and wildlife management in accordance with terms of a General Plan as provided in Section 3 of the Fish and Wildlife Coordination Act (48 Stat. 401, as amended; 16 U.S.C. 661 et seq.).

(4) That the wildlife management areas designated in Recommendation No. 3 above be developed initially at project expense to include provisions for clearing, shrub and tree planting, firebreaks, trails, headquarters buildings, fences, and surveying and marking of area boundaries according to detailed plans to be submitted by the Oklahoma Department of Wildlife Conservation.

(5) That all Federal lands be suitably marked

upon purchase so that these lands can be readily recognized as such in order to assure free public access.

Wildlife Resources -- Post-impoundment Occurrences

Land acquisition and allocation

A FWS draft report submitted to the CE on March 1, 1962 recommended the acquisition, at project expense, of additional lands outside the fee title purchase boundary suitable for developing wildlife management areas as partial mitigation for predicted project occasioned wildlife resource losses. Implementation of this FWS recommendation would have required the CE to purchase 5,197 ha (12,841 ac) of land located outside the fee purchase boundary established previously by the CE at elevation 183 m (600 ft) msl. This FWS recommendation was supported by a formal resolution submitted to the CE by the Oklahoma Wildlife Conservation Commission on August 20, 1962 (8).

However, the CE insisted that any purchase of land outside the previously established fee purchase boundary was not possible without prior congressional approval. A five-step procedure for securing congressional approval was outlined in an April 12, 1962 letter addressed to the FWS, as follows (9):

> ...Before making a recommendation to our higher authority on this proposal, I would need further justification data in order to give it full consideration. Such justification, in this case, need not be made as in the usual instance by comparing dollar estimates of economic losses with costs for such measures. Your Service should furnish complete and reliable data in support of the desired project modifications for this purpose. If such intangible interests do not clearly justify the costs of the project modification, such modification cannot be recommended.
>
> The purchase of the additional lands, and a higher estate in other project lands, if determined to be

justified, would require the prior approval of Congress. The following general procedure must be followed in considering the acquisition of additional lands:

(1) The Fish and Wildlife Service and the Oklahoma Department of Wildlife Conservation would prepare a plan of wildlife management for the project with special reference to the lands needed and which would be supported in detail, including benefits expected and method of accomplishment.

(2) This report will be furnished to the Chief of Engineers after which a meeting of Fish and Wildlife Service, Oklahoma Department of Wildlife Conservation and Corps representatives with interested Congressmen and Senators will be arranged. At this meeting, the Fish and Wildlife Service will present the plan and its justification.

(3) The views of the Governor of Oklahoma and the Director, Oklahoma Department of Wildlife Conservation would be obtained.

(4) The next step would be a public hearing in the vicinity of the project, held jointly by the Corps of Engineers and the Fish and Wildlife Service, at which the latter would present and support the plan.

(5) If it is decided to proceed with the plan after the hearing, the Corps of Engineers would process a report to Congress. The report would be prepared by the Tulsa District office and would include detailed information and recommendations upon which the authorization is to be based. Supporting data, including the report of the Fish and Wildlife Service, would be included in appendices to the report.

Although there was no evidence of FWS compliance with the five-step procedure as outlined by the CE, the final, November 15, 1962 FWS report, included the identical recommendation listed in the earlier March 1, 1962

FWS draft report. This recommendation requested the acquisition, at project expense, of the 5,197 ha (12,841 ac) tract outside the project fee title boundary as partial mitigation of anticipated wildlife resource losses. However, this recommendation was never implemented by the CE and no lands were acquired outside the fee title purchase area for wildlife mitigation purposes.

Lands acquired for the Eufaula Lake project were obtained in accordance with the so-called "Eisenhower land acquisition policy" which mandated minimal land purchase at water resource development projects. The fee acquisition boundary for the project was only 1 m (3 ft) above the top of the flood control pool [elevation 182 m (597 ft)] msl. As a consequence of this restrictive land acquisition policy, most of the project lands acquired in fee title were situated in a rather narrow band around the lake periphery. Of the total of 20,176 ha (51,187 ac) finally acquired by the fee title above the top of the power pool [elevation 178 m (585 ft)] msl, some two-thirds [16,795 ha (41,500 ac)] is located within the flood pool and is subject to periodic inundation. Most of the remaining land above the top of the flood pool [3,920 ha (9,687 ac)] has been reserved for intensive recreational use.

Wildlife habitat management (ODWC)

Although the ODWC continuously exercised statutory responsibility for wildlife resource regulation enforcement on project lands following impoundment of Eufaula Lake in 1964, no on-the-ground wildlife habitat management was undertaken by the state until the execution of a formal

license agreement with the CE on January 1, 1973. The license agreement provided for the establishment of 5 wildlife management units to be managed by the ODWC (4). These five units comprised a total of 12,900 ha (31,875 ac), including 6,475 ha (16,000 ac) of terrestrial habitat and 6,425 ha (15,875 ac) of water.

The major portion of river and/or wide creek bottomland contained on lands converted in the 1973 lease agreement were situated within the two largest units; the 2,934 ha (7,250 ac) Deep Fork area (unit 1) and the 1,457 ha (3,600 ac) Gaines Creek area (unit 5). Bottomland wildlife habitat was greatly restricted in the remaining three smaller areas which were located on the upper reaches of small creeks with extremely narrow floodplains.

Bottomland hardwood, restricted to the upper reaches of units 1 and 5, constitute the most productive wildlife habitat within the licensed areas. Typical over-story species include: water oak (Quercus nigra), willow oak (Q. phellos), chinquapin oak (Q. muelenbergii), overcup oak (Q. lyrata), sweetgum (Liquidambar styraciflua), black walnut (Junglans nigra) and pecan (Carya illineonsis). Understory vegetation of importance to wildlife common in the bottonlands includes green brier (Smilax spp.), wild grape (Vitis spp.) and poke (Phytolacia americana). Bottomlands grasses include bluestem (Andropogon gerardi), bermuda grass (Lynonon dactylon), Indian grass (Sorghastrum nutans) and Johnson grass (Sorghum halepense).

The most important overstory species common to upland area include post-oak (Quercus stellata), blackjack oak (Q. alba), persimmon (Diospyros virginiana), redbud (Cercis canadensis) and dogwood (Cornus florida). Understory species include sumac (Rhus copallina), dewberry (Rubus flagillasis), blackberry (Rubus spp.), greenbrier (Smilax rotundifolia) and hawthrone (Crataegus spp.). Important ground cover types found throughout the area of particular importance to wildlife include little bluestem (Andropogon scoparius), broomsedge (A. virginicus), ragweed (Ambrosia artemistifolia) and woody croton (Croton capilatus). Fescues, clovers and several species of the grass family are found throughout the area.

Shoreline vegetation of importance to migratory shorebirds and waterfowl is found throughout most of the units. These species include smartweed (Polygonum pensylvanicum), rice cutgrass (Leersia oryzonides) and several species of the sedge and duckweed families.

As a result of severe overgrazing permitted under previous CE stewardship, wildlife habitat quality was considered poor and wildlife populations minimal on most of the areas leased by the CE to the ODWC in 1973 (10), viz:

> ...The proposed wildlife management area has been under a livestock grazing program since the land was purchased by the Corps of Engineers. Overgrazing is the general condition on all the areas... Upland game species have limited habitat as a result of the livestock grazing program controlled by the Corps of Engineers. Consequently, no upland game species are considered abundant on any of the areas... White-tailed deer are found on all five units, but are not abundant on any. Unit 5

will support the greatest number. Most of the habitat has been limited in carrying capacity as a result of overgrazing by livestock. Other forest and marginal forest game species are found in greatest abundance on units 1 and 5. In high production years squirrels, furbearers and cottontail rabbits are fairly abundant. Swamp rabbits are found only in unit 1 and maintain fairly low populations.

The ODWC initiated on-the-ground wildlife habitat improvement activities on licensed lands in 1974, some 10 years following impoundment of Eufaula Lake. By the end of the first six years of the program (1974-1980) the ODWC had installed 48 km (30 mi) of fencing to mark property lines and control livestock trespass on two management areas, and placed some 400 boundary signs to designate the three remaining management areas. Thirteen miles of road were constructed to facilitate user access.

Earth-filled dikes, 4,267 m (14,000 ft) in length, were constructed which permitted impoundment of some 283 ha (700 ac) of green tree and emergent vegetation marshes as waterfowl feeding and resting areas. Also, ODWC project personnel planted an average of 81 ha (200 ac) of food plots annually (primarily wheat, milo and sunflower) for upland wildlife species. In addition, the ODWC negotiated and supervised sharecrop agreements with cooperators on 607 ha (1,500 ac) which provided additional food for upland game and waterfowl. These agreements stipulated that a percentage (ranging from 25 to 40 percent annually) of the crops planted (wheat, corn, milo and soy beans) be left unharvested for wildlife. In addition, 600 bobwhite quail and 18 wild trapped Rio Grande turkeys were stocked on the licensed management areas in 1976 and 1977.

With the exception of erecting boundary signs, almost all of the ODWC management activities were conducted on the Mill Creek, Deep Fork Creek and Duchess Creek units. In 1979, the ODWC initiated negotiations with the CE to amend the 1973 license agreement in order to provide for two additional wildlife management units on North and South Canadian River arms of the Lake. The two units were to replace the Longtown Creek and Gaines Creek units which had proven to be inconveniently located and appeared to offer less potential for waterfowl habitat development (11), viz:

> We wish to formally request license to the lands located on the North and South Canadian arms of the Eufaula Reservoir, and that the current lands located on the Longtown and Gaines Creek arms be withdrawn from the license.
>
> Due to the inconvenient location of these two lower units, we feel that proper, effective management cannot be accomplished; however, the licensing of the Canadian arms would allow for effective development of the Eufaula area. The potential for waterfowl and other migratory birds is much greater on the Canadian arms with proper development, whereas Longtown and Gaines Creek is most suitable for upland species that benefit with little or no management development.

This ODWC request was later amended (November, 1980) to request retention of the Gaines Creek unit in a letter from the Director of the ODWC addressed to the District Engineer, Tulsa District (12), viz:

> Following the creation of the Oklahoma Duck Stamp, we again reviewed the development potential at Eufaula and we have found that the Gaines Creek area has good potential for creation of about a 100-acre marsh. Consequently, we wish to revise our original request by retaining the Gaines Creek unit but still relinquishing control over the Longtown Creek area.

The CE rapidly expedited the changes requested by the ODWC and a new

license was executed effective January 1, 1981 (13). The new license provided the ODWC with six wildlife management units with a total area of 19,165 ha (48,469 ac) including 8,481 ha (20,956 ac) of terrestrial habitat and 11,235 ha (27,513 ac) of water area (Table 5).

Wildlife habitat management (CE)

Approximately 49 percent [10,055 ha (24,845 ac)] of the total project land area above the top of the power pool is currently allocated specifically for wildlife management purposes. However, most of the area designated for wildlife [8,481 ha (20,956 ac)] is licensed to the ODWC and only 1,574 ha (3,889 ac) is managed directly by the CE. An additional 6,056 ha (14,964 ac) of project land, although designated by the CE for low density recreational use or as natural areas, also affords wildlife habitat (Table 6).

As a result of the restrictive land acquisition policy adopted by the CE for the Eufaula Lake project, post-impoundment wildlife habitat is extremely limited and poorly situated for efficient management. Much of the land available to the CE for wildlife habitat development consists of narrow, often discontinuous, strips around the lake periphery. Wildlife population supported by these lands were low as a result of years of uncontrolled cattle grazing fostered by previous landowners (14).

Grazing and agricultural leases affecting a total of 4,749 ha (11,734 ac) of project land located above normal power pool elevation are currently in force, including 4,105 ha (10,144 ac) for grazing and 611 ha (1,590 ac) for agriculture. Of the total project area under lease, the

Table 5 -- Eufaula Lake Project. Summary of area [ha (ac)] of project land licensed to the ODWC for wildlife management under the 1973 and 1981 lease agreements

Wildlife management units	1973 lease		1981 lease	
	Ha	Ac	Ha	Ac
Deep Fork Creek	2,934	7,250	2,934	7,250
Mill Creek	647	1,600	647	1,600
Dutchess Creek	830	2,050	830	2,050
Longtown Creek*	607	1,500	2,613	6,456
Gaines Creek	1,457	3,600	1, 457	3,600
Total	6,457	16,000	8,481	20,956

* The 1981 lease provided for two additional wildlife areas on the upper reaches of the North and South Canadian Rivers, respectively, with a total land area of 2,613 ha (6,456 ac) in place of the 608 ha (1,500 ac) Longtown Creek unit which reverted to CE control.

Table 6. -- Eufaula Lake Project. Post-impoundment land use allocation above top of power pool [elevation 175 m (585 ft)][1/]

Land use category	Area		
	Ha	Ac	Percent
Project operations	250	617	1
Intensive recreation	2,260	5,584	11
State and county parks	2,095	5,177	10
Wildlife management			
Licensed to ODWC[2/]	8,481	20,956	41
Managed by CE	1,574	3,889	8
Subtotal Wildlife mgt.	10,055	24,845	49
Other[3/]	6,056	14,964	29
Total	20,715	51,187	100

[1/] The project fee title purchase area currently totals 62,076 ha (153,387 ac) including 41,360 ha (102,200 ac) within the power pool, 16,795 ha (41,500 ac) within the flood pool, and 3,920 ha (9,687 ac) above the flood pool.

[2/] Area licensed to ODWC on January 1, 1981, includes 8,841 ha (20,956 ac) of terrestrial habitat and 11,135 ha (27,513 ac) of aquatic habitat. This licensed superceded the license granted to the ODWC effective January 1, 1973 for 7,463 ha (18,440 ac) of land and 5,436 ha (13,433 ac) of water.

[3/] Includes land allocated by the CE for low density recreation and as natural areas.

directly administers grazing leases on 3,032 ha (7,493 ac) and agri-
ltural leases (hay and pecan crops) on 45 ha (110 ac). The remaining
:ases, including 1,073 ha (2,651 ac) for cattle grazing and 599 ha
1,480 ac) allocated primarily for small grain production, are located
project areas under license to the ODWC. Project land with the great-
:t potential value for wildlife habitat management has been leased to
:e ODWC or has been allocated for other project uses.

:ldlife resource management activities undertaken by the CE during the
:st few years following impoundment were restricted primarily to bound-
y signing and monumentation, to designate areas open to public hunting.
:er wildlife resource oriented management activities included the con-
:uction of hunter access facilities and the preparation and dissemi-
:ion of maps designating areas open to public hunting.

the late 1970's, the CE wildlife management program was broadened
:nsiderably by the adoption of an accelerated boundary fencing program
:ng with agressive enforcement of cattle trespass laws and regulations
effect on project lands.

CE began implementation of a long range fencing program in 1979 which
:lled for the installation of approximately 174 km (108 mi) of fence
:er a five year period from 1979-1984. Fencing was to be accomplished
:rectly by the [illegible] leases through an offset lease program ad-
ministered by the CE.

The rationale policies and procedures associated with the fencing pro-

gram were included in a memorandum issued by the Tulsa District, CE (15), viz:

> ...The continued misuse of public lands results in the general degradation of existing vegetative cover and severely restricts the amount of habitat available to wildlife. Food sources, cover, and nesting areas are destroyed, and general aesthetics of the area are degraded... Uncontrolled vegetative growth leads to proliferation of undesired species, loss of wildlife habitat, increased fire danger, and general degradation of the area. Agricultural and grazing activities will be used to improve existing vegetative condition, provide wildlife habitat, and preserve the land in optimum condition... Specific land management activities for protection, maintenance, repair, restoration, and wildlife can be accomplished by the agricultural or grazing lessee in lieu of cash rental. Eligible offset items include fencing, fertilization, erosion control, firebreaks, seeding, mowing, or brushhogging... Boundary and interior fences will be used to improve grazing lease management, to improve control of wildlife management units, delineate public hunting areas, and control unauthorized vehicular access. Fences will not be constructed adjacent to existing residential areas unless direct benefits to project management and/or adjacent landowners are received. Public access will be provided to permit continued public use... Boundary surveillance must be performed periodically from the land, water, or air to detect and prevent trespass and encroachment on public and flowage easement lands. Surveillance of project boundaries will be conducted by project personnel no less than annually and more frequently in areas posing present or potential problems...

CE implementation of the fencing program followed years of continuous pressure and encouragement from the FWS, ODWC and private conservation organizations, as well as internally generated support from the growing cadre of professional wildlife managers employed by the CE.

A letter addressed to the District Engineer, Tulsa District, from the Acting Regional Director, FWS, provides a good example of the professional wildlife manager's opinion of the value of the Eufaula project of fencing (16), viz:

> ...It is our experience that zoning of lands often is ineffective without fencing. Placement of responsibility on the public, including grazing and general recreational interests, for adherence to zoning regulations shown only by maps or occasional markers is not effective and usually cannot be made effective without a full-time staff of enforcement personnel. Thus, installation of fences is a cost saving means of implementing reservoir administration.
>
> The value of fencing as a wildlife management practice, and its necessity to the overall effectiveness of a wildlife management plan particularly in relation to livestock grazing, cannot be overstated. Relatedly; members of the Corps of Engineers, Bureau of Sport Fisheries and Wildlife, and Oklahoma Department of Wildlife Conservation interagency team, working on Appendix D to the master plans for Eufaula Lake and other reservoirs, have recognized this and have made recommendations as to where fencing should be used for wildlife management purposes. In summary, we feel fencing has substantial long-term value and economy for most types of reservoir zoning as well as being essential for wildlife management...

Additional encouragement for the CE to implement a comprehensive fencing program at the Eufaula project was provided by a letter addressed to the District Engineer, Tulsa District, by the South Central Representative of the Wildlife Management Institute (17), viz:

> ...While good monumentation may reduce encroachment on public lands, it is not as effective as fencing. Control of off-road vehicles and livestock will be minimal at best without fencing. Furthermore, managed grazing to meet vegetation management goals and/or wildlife management objectives, to reduce mowing costs, to provide revenues, etc. would be precluded on areas adjacent to residential developments...

Concurrent with the initiation of the fencing program, the CE intensified their surveillance program to prevent cattle trespass and encroachment on project lands. The help of the Assistant U.S. Attorney in Muskogee, Oklahoma in prosecuting trespassers was solicited by project mana-

ger of the Eufaula project (18), viz:

> There are several reasons for inaction on the part of the Corps to remedy this situation through the years.
>
> The most important reason being lack of personnel to monitor and follow up on these violations. Also, changing public attitudes dictate the need for more vigorous management and care of these lands is another factor.
>
> Inspection of much of this land discloses it has been abused in the past and as a result vegetative and soil damage has occurred. Although some of the areas I am referring to are fringe areas and constitute a narrow border from 100' to 300' in width, these areas are adequate, if properly managed, to provide the public a buffer between private lands and the water. These areas are also used by wildlife population as travel lanes and habitat. Some of the areas have aesthetic appeal that should be preserved.
>
> For these reasons, we are asking your assistance in removing the illegal trespass of adjacent landowners from public property.

The U.S. Attorneys Office agreed to assist with the problem of illegal cattle trespass and subsequently notified offending landowners of the governments intent to prosecute violators, as follows (19):

> ...As of this date the Corps has identified some 20 landowners who are continuing to violate the Oklahoma fencing law and have refused to control their stock and keep it off of government land. I have spoken at length with the Lake Rangers and as a rule they are generally in favor of issuing criminal citations requiring mandatory appearances on the part of the violators...
>
> The obvious solution is for the offending landowners to insure that their stock is adequately fenced and not free to roam over government land. Consequently, I have asked the Corps of Engineers to declare a

> short moratorium on the issuance of trespass citations. I am doing this so that the landowners can have a reasonable period of time, that is, 30 to 60 days, to adequately fence in their stock.
>
> Those who are not in compliance by the first of February can expect vigorous enforcement and very likely being faced with criminal prosecution in one form or another. Consequently, I urge you to take the necessary corrective action if you have not already done so...

The CE also stepped-up ongoing efforts to require potential lessees of project lands to install fences. As an inducement, the CE would provide fencing material if the lessee signed an agreement to build the fence to government specifications.

As of July 1, 1981, the CE had completed or awarded contracts for the installation of approximately 129 km (80 mi) of boundary fencing at the Eufaula Lake project through a lease offset rental program, a $1 purchase order and by construction contracts (Ben O. Carrol, Project Manager, Eufaula Lake project, CE, pers. comm., 1981). The average cost of fencing to date, has been approximately $4,350 per km ($7,000/mi) including materials and labor. An additional 97 km (60 mi) of fencing has been scheduled over the next five years.

In addition to implementing the accelerated boundary line fencing program to benefit wildlife, CE personnel have planted an average of 5 ha (12.5 ac) of food plots annually over the past five years specifically for wildlife. Also, mulberry, autumn olive, black locust and other tree species of value to wildlife have been planted by CE personnel. A total

of 8 ha (20 ac) was planted during the spring of 1980.

The CE is currently cooperating with the ODWC in developing a long-term water level manipulation plan for Eufaula Lake designed to enhance fishery and waterfowl resources. The ODWC water level manipulation plan proposed for waterfowl enhancement in 1980 involved lowering the lake level some 1.5 m (5 ft) from normal power pool elevation [178.3 m (585 ft)] beginning in July to elevation 176.8 m (580 ft) by September 10. The water level was held at this elevation through October to enable aerial seeding of the exposed mudflats with Japanese millet and wheat and to allow time for vegetative growth before letting the water level rise to elevation 177.4 m (582 ft) by the onset of waterfowl hunting season in mid-November. In addition to waterfowl benefits expected from the drawdown and seeding, fishery benefits are anticipated (20), viz:

> ...The drawdown between July 1 and September 10, will expose and aerate mudflats, allowing planting of millet and/or wheat. The millet will attract and hold waterfowl during hunting season. The wheat will provide nursery areas for fish in the spring and will help decrease overall turbidity levels in the mudflat areas...

The CE furnished the ODWC with the wheat required to seed approximately 607 ha (1,500 ac) of mudflats in 1980. Approximately 1,300 acres were planted in 1981. No CE funds were available for seed purchase in 1981, because of budgetary constraints. The seed required for the 1981 planting was purchased with funds derived locally by public subscription.

Some waterfowl benefits were achieved in 1981, although it did not prove

possible to adhere closely to the proposed drawdown amplitudes and/or time schedules in either year due to the vagaries of rainfall. In 1980, rainfall was far less than normal which prevented complete reflooding the planted mudflats during the fall. The 1981 planting was unsuccessful because of higher than average rainfall experienced early in the fall of 1981, which flooded the newly seeded mudflats before adequate vegetative growth was achieved.

Wildlife resource utilization

A substantial portion, some 16,111 ha (39,809 ac), of project lands acquired by fee title are available for public hunting. The entire area currently licensed to the ODWC, totaling 8,481 ha (20,956 ac), is open for hunting (Figure 2). Hunting is also permitted on an additional 7,630 ha (18,853 ac) which includes all of the remaining project lands except those areas allocated specifically by the CE for project operation, intensive recreation, or areas designated for state and county park use.

As a consequence of many years of intensive agriculture and overgrazing practiced by previous landowners, wildlife populations were at minimal levels on most project lands following impoundment.

Although data derived from carefully designed and statistically adequate post-impoundment hunting surveys were lacking, various estimates of hunting pressure and wildlife harvest were made by the ODWC and the CE. During the initial years following impoundment, hunting participation at

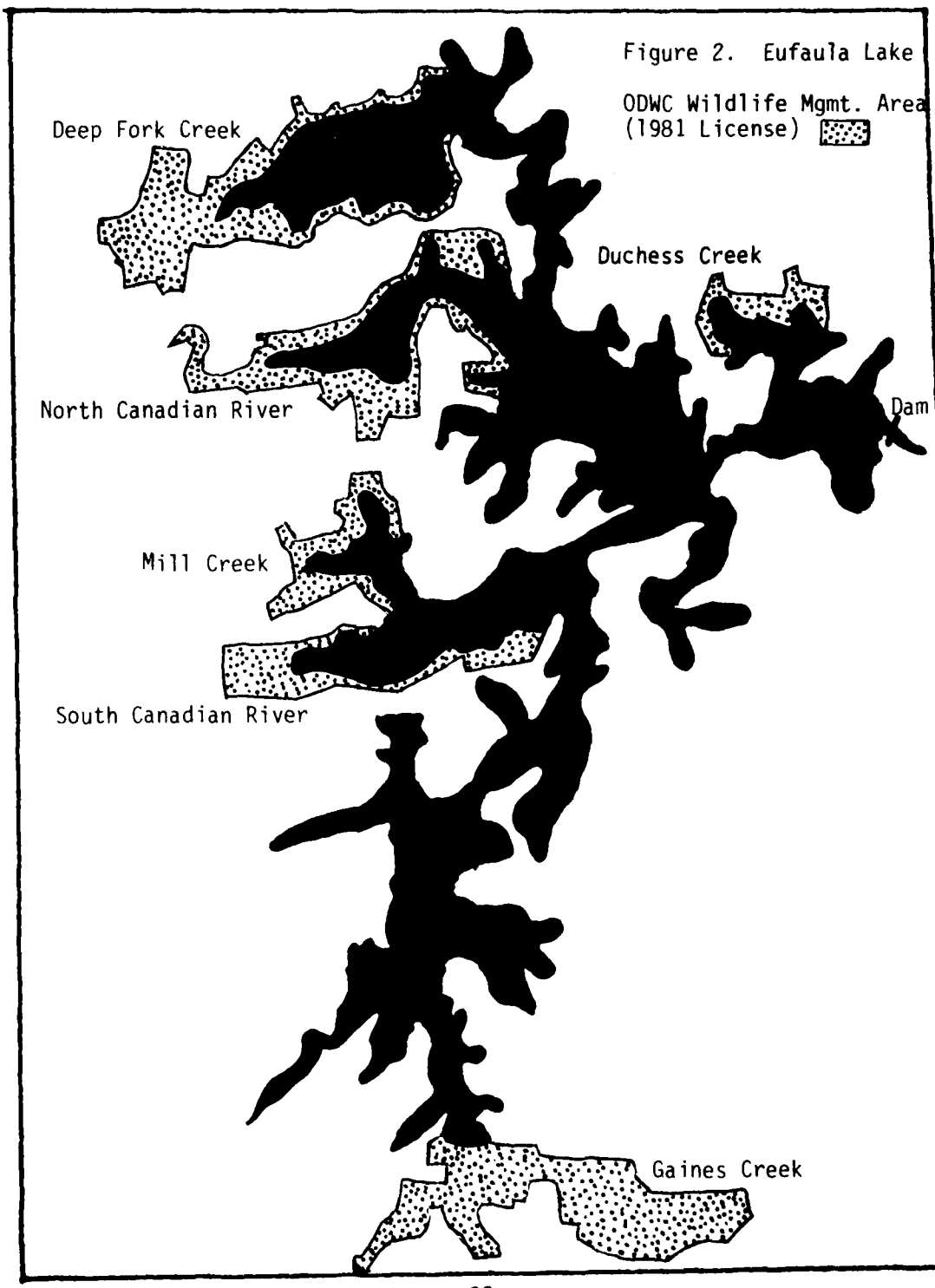


Figure 2. Eufaula Lake
ODWC Wildlife Mgmt. Area
(1981 License)
Deep Fork Creek
Duchess Creek
North Canadian River
Dam
Mill Creek
South Canadian River
Gaines Creek

the Eufaula Lake project ranked lower than any other recreational activity (1), viz:

> On the average, 80 percent of the recreation days were devoted to sightseeing and fishing, respectively, during 1976. Boating accounted for 10 percent of the recreation days during 1976 and camping and picnicking averaged 2.7 percent and 5.8 percent of the total recreation days, respectively. Only a small proportion of visitors either swim or ski, and hunting ranks lowest among use activities on project lands.

However, there was considerable disparity in the CE's estimates of hunting participation. For example, in paragraph 4.17 of the Final Environmental Statement prepared by the Tulsa District in 1974, the CE estimated that a total of 43,800 hunting man-days occurred on project lands in 1973 (2), viz:

> 4.17 Eufaula has 31,873 acres of species managed and improved wildlife habitat. The species benefitting from the management of these areas are dove, deer, quail, squirrel, rabbits and waterfowl. There were 43,800 man-hunt-days and 1,046,200 man-fish-days at Eufaula Lake in 1973.

This optimistic estimate of 43,800 hunting man-days, which amounts to a hunting pressure of over 2.5 man-day/ha (1 man-day/ac), was derived from routinely collected vehicle traffic counter data traditionally used by the CE for assessing project visitations. Such data are subject to gross misintrepretation (usually in the direction of inflated values) unless carefully collected and supplemented by extensive ground truthing.

In obvious contradictional estimates provided by vehicle traffic counters, an estimate of only 1,700 hunter man-days for upland game was reported

in paragraph 2.32 of this same CE document [1974 Final Environmental Statement (2)], viz:

> 2.32 Upland game habitat, particularly grey squirrel and cottontail areas, were most severely affected, while bobwhite, fox squirrel and mourning dove habitat is restricted to a small portion of the area within the flood control pool. The project supports approximately 1,700 man-days of upland game hunting annually.

Although white-tailed deer and waterfowl also are hunted on project lands, it is extremely unlikely that hunting pressure for these species would account for the vast discrepancy existing between the two estimates.

The 1976 CE estimate of hunting man-day use, based on the same traffic counter data collection regime as used in 1973, amounted to 45,500 hunting man-days which was some 3.9 percent higher than estimated in 1973. Data collected in later years indicated considerably lower levels of hunting man-day use, suggesting that the values reported in 1973 and 1976 were inflated.

On June 1, 1979, a directive was circulated by the office of the Chief of Engineers, Washington, D.C. to all CE Divisions that subsequent recreation attendance data collection at all civil works projects would be obtained in accordance with newly outlined procedures (21). The methodology was described in a handbook published in May, 1979, prepared by the Midwest Research Institute under contract with the CE (22).

Adoption of the new procedures as outlined in the handbook resulted in a

substantial reduction in CE estimates of hunting man-day use in subsequent years. CE estimates of hunting man-day use at the Eufaula Lake project in 1981 amounted to 24,000 hunting man-days or some 47 percent lower than the 1976 estimate (Marty Burke, Park Ranger, CE, pers. comm., 1982).

Although the ODWC did not conduct any comprehensive post-impoundment hunter use surveys designed to provide statistically valid estimates of total hunting pressure, hunter bag checks were conducted periodically from July 1, 1977 to June 30, 1980, at two of the five wildlife units managed by the ODWC under license from the CE. These two units, the 2,934 ha (7,250 ac) Deep Fork Creek unit and the 830 ha (2,050 ac) Duchess Creek unit, comprised approximately 58 percent of the total land area managed directly by the ODWC at that time [6,457 ha (16,000 ac)] and some 23 percent of the total project area open for public hunting [16,111 ha (39,908 ac)].

A total of 995 individual bag checks were made during the three year survey period. Approximately 67.5 percent of the collective hunting effort represented by the bag check data was directed to upland game species, 17.8 percent to waterfowl and 14.7 percent to white-tailed deer (Table 7). Average hunting success on the two ODWC licensed area was excellent; particularly for mourning dove (5.4 per man-day) and quail (4.3 per man-day). Waterfowl hunting success also was high. An average of over 2.5 ducks and/or geese were bagged per hunting man-day. Squirrels and rab-

Table 7. -- Eufaula Lake Project. Number of hunting man-days and game harvested per man-day recorded over a three year period (July 1, 1977 through June 30, 1980) from periodic game bag checks conducted by ODWC personnel on the Deep Fork Creek and Duchess Creek Wildlife Management Units

Species hunted	Man-days hunted		Game harvested
	No.	% of total	No./man-day
White-tailed deer			
(Gun)	93	9.3	0.11
(Archery)	53	5.4	0.05
Subtotal	146	14.7	--
Upland game			
Mourning dove	210	21.1	5.4
Quail	143	14.4	4.3
Rabbit[1/]	175	17.6	2.0
Squirrel	120	12.1	2.0
Wild turkey	24	2.4	0.2
Subtotal	672	67.5	--
Waterfowl			
Ducks	145	14.6	2.5
Geese	32	3.2	2.6
Subtotal	177	17.8	2.6
Total	995	100	--

[1/] Includes both cottontail and swamp rabbits.

bits (including both cottontail and swamp rabbits) were bagged at an average rate of two per hunting man-day, respectively. White-tailed deer were harvested at average rate of 0.1 per man-day.

Estimates of total hunting effort expended on project lands licensed to the ODWC [6,475 ha (16,000 ac)] were made by ODWC personnel during the initial year of license (1974) and again in 1980. The estimate made in 1980 was probably more accurate than the initial 1974 estimate, as a result of increased on-the-ground experience by the ODWC game managers plus information provided from sporadically collected bag check surveys during intervening years. It should be emphasized, however, that both ODWC estimates represented empirical opinion and did not reflect systematically collected hunter survey data.

A total of 2,470 hunting man-days use on the five licensed units was estimated by the ODWC in 1974 (10), as follows:

> The area has received hunting pressure when the hunters were sure of being on public lands. Unit 5 has received heavy hunting pressure for waterfowl and forest game species. Waterfowl hunting activity is created by green timber inundation during the waterfowl season.
>
> It is estimated that the area received 2,000 man-days of waterfowl hunting with a harvest of 5,000 to 6,000 birds, 120 man-days of deer hunting with a harvest of 10 deer, 150 man-days of squirrel hunting with a harvest of 300 squirrels. Other wildlife species provided 200 man-days of hunting.

Increased hunting effort following implementation of the proposed management program was anticipated by the ODWC (op. cit.), viz:

> With proposed development and use restrictions the wildlife productivity of the area is expected to increase.
>
> Waterfowl development should attract and hold many species and provide for a more consistent harvest throughout the season.
>
> Big game distribution can be expected to spread throughout the area from the existing 50 percent distribution.
>
> Upland game habitat will increase from 20 to 25 percent of potential to 100 percent under management, thus providing a much greater opportunity for harvest.

As predicted, a substantial increase in hunting pressure and harvest for all wildlife categories was indicated by ODWC estimates made in 1980 (23), viz:

> It is estimated from hunter surveys that the area received 3,000 man-days of waterfowl hunting with a harvest of 8,000 birds, 500 man-days of deer hunting with a harvest of 25 deer, 1,050 man-days of squirrel hunting with a harvest of 3,000 squirrels. Other wildlife species provided 800 man-days of hunting.

Estimated total hunting man-day use on ODWC wildlife management areas in 1980 was more than double that estimated in 1974. Hunting man-days use estimated in 1980 for white-tailed deer and upland game species was some 400 percent higher than in 1974. Waterfowl hunting man-day use was estimated to have increased by 50 percent over this same period (Table 8).

Table 8. -- Eufaula Lake Project. Comparison of hunting man-day use on licensed project wildlife management areas estimated by the ODWC for 1974 and 1980 hunting seasons

	Hunting man-day use				
	White-tailed deer	Upland game	Subtotal	Waterfowl	Total
1974 season	120	350	470	2,000	2,470
1980 season	500	1,850	2,350	3,000	5,350
Percent increase	317	429	400	50	117

Wildlife Resources -- Evaluation of Planning Input

Adequacy of planning recommendations

The first examination of the Eufaula Lake project site by the FWS was made in conjunction with a study of three potential reservoir sites requested by the Tulsa District of the CE in 1948. Findings from this study were incorporated in a FWS report issued in January, 1950. This initial planning report appeared to satisfy its primary objectives, i.e., to provide decision makers with sufficient information to compare the relative impact of proposed development regimes on wildlife resources at three alternate reservoir sites located in the Canadian River watershed. The report presented a comprehensive, in site assessment of wildlife communities and utilization at each site, predictions of probable impacts of development on these wildlife resources, and appropriate recommendation for mitigation and/or enhancing wildlife resources impacted at each site.

Practical suggestions for mitigating expected losses of upland game resources were offered, such as granting agricultural leases to augment wildlife food production. The importance of adherence to the principal of "in kind" replacement for wildlife resource mitigation was emphasized throughout the report.

Much of the baseline information presented in the initial 1950 FWS planning report was later incorporated in the final November 15, 1962 FWS report which dealt specifically with the Eufaula Lake project.

The final FWS planning report of November 15, 1962 contained four recommendations pertinent to mitigation of wildlife resource losses anticipated from construction of the Eufaula project. These recommendations included provision for (1) development of zoning plan in concert with the ODWC that would provide adequate areas within project boundaries for hunting; (2) that all such areas be clearly marked to assure free public access; (3) that approximately 5,197 ha (12,841 ac) of land located outside the approved project purchase boundary be acquired in fee title at project cost and, together with other incidentally acquired project lands located within the approved purchase boundary some 6,475 ha (16,000 ac), be licensed to the ODWC for wildlife management purposes; and (4) that these designated wildlife management areas be developed initially at project expense. Recommended development activities included shrub and tree planting, construction of firebreaks, trails, headquarters buildings, fences, and surveying and marking of boundaries according to detailed plans submitted by the ODWC.

These FWS recommendations appeared to be well conceived and, if fully implemented, appropriate for substantially mitigating the predicted wildlife resource losses.

The first two FWS recommendation subsequently have been implemented. An adequate zoning plan, developed in cooperation with the ODWC, has been adopted for project lands. All suitable project lands are open to public hunting with the exception of lands required for project operations. Lands dedicated for state and county parks (hunting on these lands pro-

hibited by state laws), lands zoned for intensive recreation and lands in the immediate vicinity of buildings and project structures.

Although post-impoundment signing and monumentation of project boundaries as recommended by the FWS proceeded expeditiously, substantial progress in fencing project boundaries was not achieved until recently (1979). The prolonged hiatus (from 1964 to 1979) in the adoption of a trenchant boundary fencing program by the CE was regretable and contributed to the continuance of the overgrazed condition of project lands administered directly by the CE.

The November 15, 1962 FWS report recommendations concerning the acquisition and initial development, at project expense, of wildlife management areas for license to the ODWC have been only partially implemented. Areas within the original project purchase boundary were initially licensed to the ODWC early in 1973, some eight years following impoundment of Eufaula Lake. The long delay in consumating the license agreement apparently reflected the reluctance and/or inability of the ODWC to assume financial obligation for developing the areas, as the CE had offered to license the areas to the ODWC shortly after impoundment of Eufaula Lake. However, the CE did not purchase the 5,197 ha (12,841 ac) ancillary wildlife management tract located outside the project purchase boundary as recommended by the FWS. Likewise, the FWS recommendation for financing the initial wildlife area development costs of lands licensed to the ODWC (fencing, surveying, etc.) at project expense was never implemented. Costs associated with the subsequent development of these wildlife

management areas have been borne entirely by the ODWC.

Accuracy of FWS predictions

The FWS considered that implementation of the November 15, FWS report recommendation for the purchase and subsequent development of the 5,197 ha (12,841 ac) tract outside the proposed project purchase boundary at project expense to be crucial for mitigating predicted wildlife resource losses associated with the permanent flooding of some 40,551 ha (102,200 ac) of project lands. The FWS predicted that intensive ODWC management of this proposed tract, plus an additional 6,472 ha (16,000 ac) area located within the approved project purchase boundary, would materially compensate for terrestrial wildlife losses resulting from impoundment and provide an additional 5,000 waterfowl hunting trips annually (Table 9).

With full implementation of the FWS recommendations, the project was expected to support an annual hunting pressure of 17,800 man-days annually; including 200 man-days for white-tailed deer, 10,100 man-days for upland game and 7,500 man-days for waterfowl.

Without implementation of their recommendation for supplemental land acquisition and development, the FWS predicted that hunting man-day use on the project would be drastically reduced for upland game and white-tailed deer, although hunting man-day use for waterfowl was expected to increase with the project in place.

As indicated by hunting man-day use estimates for licensed lands made by the ODWC in 1980, the November 15, 1962 FWS report predictions considerably

Table 9. -- Eufaula Lake Project. Comparison of hunting man-day use estimates as predicted by the FWS (November 15, 1962 report) with estimates of current use made by the ODWC and the CE

Game category	FWS predictions			Current use estimate	
	Without project	With project in place		ODWC (Licensed land)[1/]	CE (Total project)[2/]
		Without mitigation plan	With migitation plan		
White-tailed deer	200	0	200	500	--
Upland game	10,800	1,700	10,100	1,050	--
Subtotal	11,000	1,700	10,300	1,550	--
Waterfowl	560	2,500	7,500	3,000	--
Total	11,560	4,200	17,800	4,550	24,000

[1/] Estimate restricted to hunting effort on the 6,475 ha (16,000 ac) land area managed by the ODWC.
[2/] Encompasses total project area (terrestrial) open to hunting [16,111 ha (39,908 ac)].

underestimated post-impoundment hunting effort for white-tailed deer. The ODWC estimate of hunting effort for white-tailed deer on licensed lands (500 hunting man-days) was some two-and-one-half times greater than the 200 man-days per year predicted by the FWS for the entire project, including the 5,197 ha (12,841 ac) tract outside the purchase boundary which was never acquired. Without the acquisition of recommended mitigation lands, the FWS predicted that big game hunting man-day use on the project would be insignificant. It seems apparent the resurgence of white-tailed deer on the project area (which also occurred generally throughout the nation during the 1960's) was not anticipated by the authors of the 1962 FWS report.

FWS predictions pertinent to post-impoundment hunting effort for upland game appeared to be more in line with estimated post-impoundment occurrences. Post-impoundment hunting effort for upland game on licensed lands (only) was estimated by the ODWC at 1,050 man-days per year in 1980, or some 0.16 man-days per hectare (0.066 man-days/ac). With the assumption that an approximately equivalent level of hunting pressure occurred on unlicensed project lands, the total project area [16,111 ha (39,809 ac)] open to public hunting, would have supported approximately 2,560 hunting man-days for upland game species. This value is slightly higher than the FWS prediction of 1,700 man-days per year without acquisition of the recommended mitigation tract, but substantially lower than the 10,100 man-days predicted with full implementation of the recommended mitigation plan.

The post-impoundment FWS waterfowl hunting man-day use prediction of 2,500 man-day per year without the implementation of the mitigation plan and 7,500 man-days per year with implementation, appeared reasonably accurate. The ODWC estimated that 3,000 waterfowl hunting man-days occurred on licensed lands in 1980.

Based on these post-impoundment hunting man-day use estimates developed by the ODWC for licensed lands, it seems likely that full implementation of the mitigation plan proposed by the FWS in the November 15, 1962 planning report would have substantially alleviated predicted project occasioned wildlife resource losses.

FISHERY RESULTS AND DISCUSSION

Fishery Resources -- Pre-impoundment Predictions

The fishery resources associated with the Eufaula Lake project were first evaluated by the FWS in a planning report and dated January, 1950 which was prepared in response to a request received from the District Engineer, Tulsa District, CE, in 1948. The proposed Eufaula Dam was located at river mile 27 on the mainstream of the Canadian River and was designed to provide for flood control, hydroelectric power, navigation and sediment control benefits.

This January, 1950 FWS planning report also considered an alternate project proposed in lieu of the Eufaula Lake project, consisting of two smaller reservoirs located on the North and South Canadian Rivers in the same general vicinity. Sediment storage and flood control functions were to be accommodated principally at the Onapa Reservoir, located on the North Canadian River, and hydroelectric power production at the Canadian Reservoir site located on the South Canadian River. All inflow surplus to power generation needs would be diverted from the Canadian Reservoir to Onapa Reservoir via an uncontrolled saddle spillway connecting the two reservoirs.

The major streams located within the impact area of the proposed projects (Canadian River, North Canadian River, and South Canadian River) were heavily silted with unstable bottom structure. The streams were subject to fish kill during extreme low flow periods as a result of oil

field brine wastes primarily, plus mining and domestic pollutants. These rivers supported only a small amount of sport fishing by angling and trot line for channel catfish, flathead catfish, bullhead, carp, buffalo (both bigmouth and smallmouth), and quillback. Angling success was better on the Deep Fork River and Gaines Creek tributaries (5), viz:

> Deep Fork River and Gaines Creek contain the principal fisheries resources of the project area. These streams have stable bottom conditions and are not heavy silt bearers, though Deep Fork River is seldom clear. Anglers catch a few largemouth black bass, other sunfishes, and channel catfish, and considerable trotline fishing for sport is done on these streams. There are several minor streams within the project area which yield channel and flathead catfish, and a few of them supply moderate fishing for largemouth black bass and sunfishes.

Limited commercial fishing was also conducted on streams within the project area (op. cit.), viz:

> A few commercial fishermen, using trot lines and seines, take flathead catfish, bullheads, freshwater drum, carp, bigmouth buffalo and smallmouth buffalo, quillbacks, paddlefish, and American eels.

A substantial improvement in water quality was expected, both in the reservoir and tailwater as a result of impoundment (op. cit.), viz:

> Pollution entering any of the reservoirs is not expected to exert a deleterious effect upon the biota therein, since pollution concentrations will be small when mixed with the total storage capacity of any reservoir. The mixing action of the reservoirs and large minimum released below Eufaula and Canadian Reservoirs should dilute any pollution present in the lower river to a concentration well below any point of harmful effects.

Although substantial losses of poor quality stream habitat were expected as a result of impoundment, an overall net annual fishery benefit was predicted with implementation of either the Eufaula project ($202,000 per year) or the alternative Canadian/Onapa project complex ($66,000 per year).

The higher fishery value assigned to the Eufaula project was attributed primarily to values inherent with the larger size and better water quality associated with the proposed Eufaula reservoir [36,059 ha (89,100 ac)], as compared to 21,490 ha (53,100 ac) contained in the two reservoirs proposed for the Canadian/Onapa project (Table 10).

No specific recommendations were offered in the January, 1950 FWS planning report for mitigating anticipated fishery losses or for enhancing fishery benefits, although several general areas were addressed (op. cit.), viz:

> Investigations to determine the practicability and desirability of the various means of mitigating losses and increasing the benefits of fish and wildlife in connection with the Eufaula project, under either plan of development, would require considerable time and effort. Such detailed study should be undertaken following the determination as to which plan will be adopted, since those studies would be relatively expensive. However, from the studies carried on to date, several means are apparent whereby wildlife or fisheries values might be enhanced under postproject conditions. These possibilities include water-level management, fish-concentrating structures, minimum released from reservoirs... Such proposals would need to be studied indetail in cooperation with the Oklahoma Game and Fish Department, the Oklahoma State Health Department, and the U.S. Public Health Service before

Table 10. -- Eufaula Lake Project. Predicted changes in the fishery habitat resource base and annual sport fishery monetary values expected from construction of the Eufaula Lake project as compared to construction of the Canadian/Onapa Reservoir complex. Data extracted from the January, 1950 FWS planning report (5)

	Eufaula project			Canadian/Onapa project		
	Without project	With project	Net (With project)	Without project	With project	Net (With project)
Resource base						
Streams [kl (mi)]						
Above dam	438 (272)	74 (46)	-364 (226)[1/]	336 (209)	92 (57)	-244 (152)[2/]
Tailwater	43 (27)	43 (27)	No change	93 (58)	93 (58)	No change
Total	481 (299)	117 (73)	-364 (226)	429 (267)	185 (115)	-244 (152)
Reservoir [ha (ac)]	0 0	36,059 (89,100)	+36,059 (89,000)	0 0	21,490 (53,100)	+21,490 (53,100)
Value($)						
Streams						
Above dam	33,000	5,000	-28,000[1/]	34,000	14,100	-19,900[2/]
Tailwater	5,400	20,000	+14,600	9,600	17,000	+7,400
Total	38,400	25,000	-13,400	43,600	31,100	-12,500
Reservoir	0	210,000	+210,000	0	75,400	+75,400
Total value($)	38,400	235,000	+196,600	43,600	106,500	+62,900
Rounded total	38,000	240,000	+202,000	44,000	110,000	+66,000

[1/] Reflects loss of 364 kl (226 mi) of streams permanently inundated within power pool.
[2/] Reflects eventual loss of 143 kl (89 mi) of streams inundated within original sediment pool [77 kl (48 mi,)] and ultimate sediment pool [66 kl (41 mi)] at the Onapa Reservoir plus the loss of 101 kl (63 mi) of stream inundated within the power pool of the Canadian Reservoir.

definite recommendations could be made.

A decision was reached by the CE to proceed with the development of the Eufaula Lake project in lieu of the combined Canadian/Onapa Reservoir complex subsequent to the transmittal of the initial January, 1950 FWS planning report. Land acquisition and premilinary planning for the Eufaula project was initiated in the early 1950's. Dam construction commenced in 1956. The only substantial design change made by the CE for the Eufaula Lake project in the interum was a proposed increase in size of the reservoir at full power pool from 36,018 ha (89,000 ac) to 41,482 ha (102,500 ac).

The final FWS planning report was submitted to the CE on November 15, 1962, some six years following initiation of project construction and less than two years before dam closure for flood control in February, 1964 (6). Pre-impoundment of fishery resources provided by the Canadian River, North Canadian River and tributary streams located within the project impact area [totalling some 483 km (300 mi)] were described in the November 15, 1962 FWS report as follows:

> The streams that will be affected by the project are expected to sustain only poor to moderate production of sport fishes. Most of the streams are subject to extreme fluctuations, carry large amounts of sediment, are turbid, and have high summer temperatures during extended periods of low flow. The Canadian and North Canadian Rivers flow within broad channels, the streams normally occupying only small portions of the river beds, which are sandy and subject to shifting during high water. The smaller streams in the area flow within narrow deeply entrenched channels, which have bottoms consisting principally of

silt with occasional outcropping of solid rock.

> The principal fishes in the streams to be affected by the project are buffalo fishes, carp, channel catfish, flathead catfish, freshwater drum, river carpsucker, gizzard shad, redhorse, gars, bullheads, various sunfishes, paddle fish, largemouth bass, crappies, and many species of minnows. The sport fishes must compete for food and space with much larger numbers of undesirable fishes; consequently, such competition, together with the unfavorable environmental conditions, is sufficient to limit the sport fishes to comparatively small numbers.
>
> The amount of fishing on streams within the reservoir site is low. Pole and line and the use of trotlines to take catfish are the most popular methods of fishing. The number of good fishing holes in the river are few and angling is concentrated at favored locations such as Standing Rock which is located about five miles downstream from Eufaula. At no place is the fishing of outstanding quality. It does, however, offer fishing for local people and provides a source of food fish for low-income families. The interest of the people of Oklahoma in fishing is high, as demonstrated by the great distances many of them travel to fish in reservoirs and streams that provide good fishing. This high interest is also reflected in the amount of fishing done on the unstable and turbid streams, such as the Canadian River where fish production if low.

Without the project, the FWS estimated that the streams affected by the project would support average annual use of only 14,000 recreational fishing man-days per year over the assumed 50-year project life.

Commercial fishing opportunities in streams within the project impact area were limited by constraints imposed by the low stream productivity and harvest regulations (op. cit.), viz:

> The volume and success of commercial fishing expected without the project is low to moderate. Species of commercial importance are buffalo fishes, catfishes,

> carp, carpsuckers, freshwater drum, gar fishes, gizzard shad, redhorse suckers, and various species of bait minnows. Restrictions do not permit taking of the total potential. If regulations were to permit a more complete utilization of the fishery, the streams which will be affected by the Eufaula Reservoir project could produce 172,000 pounds of commercially harvestable fishes with a value of approximately $11,000 annually.

The November 15, 1962 FWS report provided a thorough discussion of the predicted impacts of project construction on the fishery resources within the project impact area. Major physical parameters of the proposed Eufaula Lake project were described in the November 15, 1962 FWS report as follows:

> Eufaula Reservoir at the top of power pool will inundate approximately 300 miles of streams and will create a 102,500-acre lake with an irregular 600-mile shoreline. The entire stream fish habitat within this pool will be lost. The main body of the reservoir will have four principal arms and extend upstream from the dam for about 37 miles. Water levels will be relatively stable, having an average annual fluctuation of about 7.6 feet. Flood fluctuations generally will be of short duration, with the water level returning to power pool elevation within a few days.

A diversified warmwater fish community was expected to develop within the lake including both sport and commercial fishes (op. cit.), viz:

> The water in the reservoir is expected to be murky but will provide attractive habitat for largemouth bass, crappies, channel and flathead catfishes, sunfishes, and white bass, as well as carp, buffalo fishes, shad, carpsuckers, freshwater drum, gars, and other fishes.

Declining fish productivity, especially for largemouth bass, was predicted

as the lake aged (op. cit.), viz:

> Fish production is expected to follow the pattern of other reservoirs in the state in which large-mouth bass provide significant sport fishing during the initial years of impoundment but declining as fish populations become stabilized.

Non-game species, on the other hand, were expected to increase in abundance as the lake matured posing control problems in future years.

Annual post-impoundment recreational fishing man-days use at the Eufaula Lake project was expected to increase almost nine-fold over the 14,000 man-days per year estimated for impact area streams without the project (op. cit.), viz:

> Eufaula Reservoir will provide productive reservoir fish habitat which will attract many fishermen from distances of more than 100 miles. A variety of angling conditions for both bank and boat fishing will be available. Although it is located in the general area of other large impoundments, the reservoir can be expected to provide an average of 113,000 man-days of fishing annually.

An additional 12,000 man-days per year of recreational fishing was predicted for the 43 km (27 mi) Canadian River tailwater (op. cit.), viz:

> Flows in the 27 mile segment of the Canadian River downstream from the dam are expected to fluctuate severely on a daily basis, but assuming that water quality is adequate to support fish, the fishing will be improved over that during without-the-project conditions. Stream fishing in the project area will amount to about 12,000 man-days annually with the project.

The commercial fish harvest with the project in place was expected to average 317,500 kg (700,000 lbs) per year with a market value of $52,000

(op. cit.), viz:

> Commercial fishing opportunities in the reservoir are expected to be good. Rapid growth and high reproduction are expected to characterize commercial fish populations during the initial years following impoundment of the reservoir. Substantial number of fishes suitable for marketing should be available within three years. After the fish populations become stabilized, the growth rate of the fishes is expected to decline with annual yields slightly reduced. It is estimated that **the reservoir and affected streams will provide a potential commercial catch of about 700,000 pounds of fish annually with a marketable value of $52,000. No benefit can be attributed to this catch, however, since extensive commercial fishing in Oklahoma is greatly restricted at present.**

The November 15, 1962 FWS report presented a series of well conceived recommendations designed to assure optimum utilization of project associated fishery resources. These recommendations were presented and discussed in the planning report as follows:

> It is recommended:
>
> 1. That a minimum instantaneous release of 200 second-feet of water capable of supporting fish life be discharged into the Canadian River to the extent that existing water rights permit, and that such releases be based on a 10-year critical recurrence interval... Due to the absence of specific power operational information, the appraisals contained in the report are based on the assumption that the pattern of power released will be similar to those at existing reservoirs and will provide sufficient high quality water to prevent complete loss of fish from the stream. It is recognized that fish losses would occur during prolonged periods of low flows, and if permitted frequently, the stream fishing anticipated with the project would be curtailed...
>
> A sustained flow of 200 second-feet would miti-

gate stream-fishing losses and would provide enhanced fish habitat. It is estimated than an additional 5,000 fisherman-days valued at $5,000 annually could be assigned to the project if a sustained release of 200 second-feet is made.

Although it is probable that the released water will contain sufficient oxygen to sustain the fishery, provisions should be made to assure oxygenated tailwaters. There is the possibility that water released from lower elevations of the reservoir may be deficient in oxygen. Consequently, consideration should be given in project design and operation, possibly through the use of a Howell-bunger type valve, to assure that the proper quality of water is released. The Oklahoma Department of Wildlife Conservation will assist in this phase of planning...

2. That 10 areas be marked and designated as seining areas... Control of rough fish is expected to become a problem within the reservoir. Seines and other nets are used in the control program and are also used by commercial fishermen. These methods are best employed where a sizeable area of the reservoir bottom is free of obstructions. Areas within the power pool elevation that are clear or are reasonably free of obstructions should be marked prior to inundation and designated as seining areas.

3. That timber clearing within the reservoir area be held to a minimum, except for parking and boat-launching areas, for areas required for construction and operation of the project, and for those areas deemed necessary to preserve public health.

4. That public access be assured by maintaining those State and county roads within the project area as designated by the Oklahoma Department of Wildlife Conservation.

5. That public access to the tailwater fishery be assured by provision of a parking area on project lands downstream from the dam.

6. That a fishing platform be constructed down-

stream from the dam by the Corps of Engineers to provide a safe and efficient means whereby anglers can take full advantage of the tailwater fishery. Location of the platform will be determined by the coordinated efforts of the Oklahoma Department of Wildlife Conservation, Corps of Engineers, and the Bureau of Sport Fisheries and Wildlife after operation of the reservoir has demonstrated the most desirable location... The estimated cost of construction of the fishing platform downstream from the dam is $10,000.

7. That boat-launching ramps be constructed at all parking and recreation areas adjoining the reservoir.

A recapitulation of FWS fishing man-day use predictions without the project and with the project in place is presented in (Table 11).

Table 11. -- Eufaula Lake Project. Summary of the November 15, 1962 FWS predictions of average annual recreational fishing man-days use and commercial fishery harvest without the project and with the project in place

	Recreational fishery		Commercial harvest	
	No. man-days	Value($)[1/]	Kl (lbs)	Value($)
Without project				
Total	14,000	$ 14,000	78,019 (172,000)	$ 11,000
With project				
Without mitigation				
Reservoir	113,000	113,000		
Tailwater	12,000	13,000		
Total	125,000	125,000	317,460 (700,000)	52,000
With mitigation				
Reservoir	113,000	113,000		
Tailwater[2/]	17,000	17,000		
Total	130,000	130,000	317,520 (700,000)	52,000
Net without mitigation	+99,000	+99,000	239,501 (528,000)	42,000
% increase	707	707	307 (307)	382
Net with mitigation	104,000	104,000	339,501 (528,000)	42,000
% increase	743	743	307 (307)	382

[1/] Computed at $1.00 per fishing man-day.
[2/] Reflects additional 5,000 fishing man-days per year which would be provided by implementation of the FWS recommendation of a 200 cfs minimum flow in the tailwater.

Fishery Resources -- Post-impoundment Occurrences

Eufaula Lake was impounded in February, 1964. Power production commenced July 27, 1964. The lake contained approximately 41,482 surface ha (102,500 ac) at full power pool elevation when first impounded. Siltation has since reduced the area to an estimated 41,070 ha (101,483 ac). The lake includes a variety of contrasting habitats and aquatic communities. Water transparency has varied from less than 15 cm (6 in) to more than 1 m (3.28 ft) depending on location and weather conditions (24).

There is a wide variety of shoreline substrates including mud (36 percent), rock (34 percent), sand (13 percent), silt (11 percent), clay (4 percent), and rip-rap (3 percent). Approximately 53 percent of the shoreline has a gentle slope of 15 degrees or less. Some 33 percent of the shoreline is classified as moderately sloping (15-30 degree slope), 11 percent as sharply sloping (30-60 degree slope), with the remaining 3 percent of the shoreline characterized as cliff (60-90 degree slope).

Fish community studies

The ODWC has monitored the Lake Eufaula fish community periodically since impoundment. Cove rotenone sampling was conducted during the summer and fall (July - September) in 1972, 1977, 1979 and 1980. Cove rotenone sampling effort was most extensive in 1972 [six coves totalling 4.9 ha (12 ac)]. Sampling in subsequent years included two coves totalling 0.93 ha (2.3 ac) in 1977, two coves in 1979 totalling 1 ha (2.6 ac) and three coves in 1980 totalling 2 ha (4.9 ac). Procedure followed in obtaining the cove rotenone samples were as outlined in the ODWC publi-

cation "Standard Sampling Procedures for Lake and Reservoir Management Recommendations" (25).

Selected coves were surveyed to determine surface area and water volume. Various fish species were collected outside the experimental cove, appropriately marked and released in the experimental cove behind a block-off net placed at the mouth of the experimental cove the evening prior to the application of rotenone.

Fish pick-up commenced immediately after rotenone application and was continued for two days. Data obtained from the recovery of marked fish was used to adjust estimates of fish standing crops.

The cove rotenone samples provided gross estimates of the fish community standing crop within Lake Eufaula, subject to the inherent limitations of cove rotenone sampling techniques (poor representation of crappie, white bass, and other highly mobile species partial to demersal and/or pelagic habitats in deeper water). Analysis of the cove rotenone samples indicated that the lake supported a rich and diverse fish community typical of other large reservoirs located within the same watershed.

A total standing fish crop of 734 kg/ha (655 lbs/ac) was estimated in 1972, the year in which the most extensive sampling was conducted. The total standing crop in subsequent years ranged from a low of 516 kg/ha (461 lbs/ac) in 1977 to a high 1,159 kg/ha (1,034 lbs/ac) in 1979 Table (12).

Gizzard shad and other non-game species (primarily carp, drum, smallmouth

Table 12. -- Eufaula Lake. Summary of fish community standing crops estimates based on cove rotenone samples collected by the ODWC during July and August in 1972, 1977, 1979, 1980

	kg/ha (lbs/ac)				% composition (wt)			
	1972	1977	1979	1980	1972	1977	1979	1980
Black bass[1/]	9.0 (8.0)	16.1 (14.3)	13.3 (11.9)	5.7 (5.1)	1.2	3.1	1.2	0.8
White bass	7.3 (6.5)	0.7 (0.6)	3.1 (2.8)	0.2 (0.2)	1.0	0.1	0.3	tr.
Crappie[2/]	11.4 (10.2)	10.1 (9.0)	26.6 (23.7)	4.1 (3.7)	1.6	2.0	2.3	0.6
Sunfish[3/]	30.7 (27.4)	46.7 (41.7)	47.8 (42.6)	33.0 (29.4)	4.2	9.1	4.1	4.7
Subtotal	58.4 (52.1)	73.5 (65.6)	90.8 (81.0)	43.0 (38.4)	8.0	14.2	7.8	6.2
Catfish[4/]	59.3 (52.9)	37.4 (33.4)	92.0 (82.1)	52.0 (46.4)	8.1	7.3	7.9	7.5
Nongame fish[5/]	249.4 (222.5)	189.3 (168.9)	500.1 (446.9)	179.4 (160)	34.0	36.7	43.2	25.7
Gizzard shad[6/]	367.2 (327.6)	215.9 (192.6)	475.1 (423.8)	423.4 (377.7)	50	41.8	41.0	60.7
Grand total	734.4 (655.1)	516.2 (460.5)	1158.9 (1033.8)	697.8 (622.5)				
Total less shad	368.2 (328.5)	300.3 (267.9)	683.8 (610.0)	274.4 (244.8)				

[1/] Primarily largemouth bass with some spotted bass.
[2/] Primarily white crappie with some black crappie.
[3/] Primarily bluegill and green sunfish; with some longear sunfish, redear sunfish, orange spotted sunfish, warmouth.
[4/] Includes channel catfish, blue catfish, and flathead catfish.
[5/] Includes carp, smallmouth and bigmouth buffalo, river carpsucker, and drum.
[6/] Includes small amount [≤1 kg/ha (1 lb/ac)] of minnows, darters and other small forage species in addition to gizzard shad.

buffalo, river carpsucker) collectively comprised the major portion of the estimated fish community standing crop in each of the four years cove rotenone sampling was conducted. The most popular recreational fish species (black bass, crappie, white bass, catfish and sunfish) averaged less than twenty percent of the average standing fish crop over the four year sampling period. No readily discernable trend in abundance of any particular species was apparent from the data.

Success of reproduction was evaluated from shoreline seine samples collected by the OWDC in 1977, 1978, 1979, and 1980. Extensive cove rotenone samples collected in 1972 also provided usable data for evaluating fish reproduction. The shoreline seine samples were obtained by small mesh seines approximately 12.2 m x 1.8 m (40 ft x 6 ft). Smaller seines, 6.1 m x 1.8 m (20 ft x 6 ft), were also used on occasion. Seining was accomplished by holding one end of the seine stationary at the water's edge while pulling the other end of the fully extended net through the water column to shore.

Collected fish were sorted by species, counted, measured and recorded as the number of fish obtained per 100 m^2 of water sampled (Table 13). Seining effort was most extensive in 1979 (57,000 m^2) and in 1980 (35,000 m^2 sample area). An area of 4,290 m^2 was sampled in 1979 and 3,480 m^2 in 1978.

It should be emphasized that the number of fish collected per 100 m^2 over the various years represent only indices of abundance. Fish escape-

Table 13. -- Eufaula Lake. Number of young-of-year fish captured per 100 m^2 by shoreline seining during June and July in 1977, 1978, 1979 and 1980. Data for 1972 represents the number of young-of-year fish recovered per 100 m^2 from cove rotenone sampling (June - September)

Year and sample size (m^2)	Number captured per 100 m^2						
	Largemouth bass	Spotted bass	White bass	Crappie[1/]	Sunfish[2/]	Channel catfish	Forage species[3/]
1972 (48,887)	1.6	tr.	0.[illegible]3	3.4	32.6	1.8	41.9
1977 (4,290)	0.62	0.02	0.28	2.1	26.0	0.0	57.8
1978 (3,480)	3.22	0.17	5.03	0.69	N.A.[5/]	0.09	30.5
1979 (57,000)	0.91	0.09	.27	1.1	2.75	0.01	5.9
1980 (35,100)	.16	0.11	.35	0.04	1.77	0.01	41.3

1/ Primarily white crappie, with less than 1 percent black crappie.
2/ Includes bluegill, green sunfish, longear sunfish and warmouth.
3/ Primarily gizzard shad and Mississippi silversides, threadfin shad were also taken in 1979 and 1980.
4/ Data not available.
5/ Data not available.

ment from the small seines utilized in the investigation undoubtedly was high. Also, the concentration of small fish is, no doubt, higher in areas of heavy brush cover than in the relatively open areas amenable to the seining techniques employed in the sampling program.

Analysis of the shoreline seining data indicated successful reproduction by all sport fish and prey species occured each year with the single exception that no young-of-year channel catfish were collected in 1977. However, young-of-year channel catfish were collected by cove rotenone sampling in 1977, indicating a successful spawning effort. Reproduction indices for the three major predator sport fish species (largemouth bass, spotted bass and white bass) were each higher in 1978 than in any other year.

Electrofishing samples were also collected by the ODWC during the spring of 1977, 1978 and 1979. Comparable collections were made during the fall months each year from 1977 through 1980. Electrofishing was conducted with a boom type boat utilizing a 240 volt A.C. generator. Data was reported by the number of fish caught per 15 minutes sampling interval (Table 14).

Largemouth and spotted bass exhibited little temporal change in abundance over the four-year sampling period. Both species registered slight gains in abundance in the 1980 collections as compared to earlier years. The mean size of both species was smaller in samples collected in the fall as compared to spring collections, suggesting high angling morta-

Table 14. -- Eufaula Lake. Number and mean weight of largemouth bass, spotted bass, white crappie and gizzard shad collected per 15 minute interval of electroshocking during the spring and fall. 1977 through 1980

	1977			1978			1979[1/]	1980		
	Spring	Fall	Ave.	Spring	Fall	Ave.	Fall	Spring	Fall	Ave.
Largemouth bass										
Number/15 min. sample	3.42	2.83	3.1	2.67	4.0	3.3	5.0	1.35	6.0	3.7
Kg (mean)	0.369	0.221	0.30	0.513	0.444	0.48	0.38	0.518	0.265	0.39
Lb (mean)	0.81	0.48	0.66	1.13	0.98	1.1	0.84	1.14	0.58	0.86
Spotted bass										
Number/15 min. sample	1.08	.17	0.63	.58	0.50	0.54	0.16	0.32	1.30	0.81
Kg (mean)	0.191	.011	0.10	0.202	0.119	.161	0.18	0.196	0.109	0.15
Lb (mean)	0.399	.0243	.21	0.445	0.262	.35	0.42	0.432	0.240	0.34
White crappie										
Number/15 min. sample	0.75	0.67	.71	0.50	.25	.38	0.47	0.46	0.63	0.54
Kg (mean)	0.175	0.408	.29	0.315	0.372	0.34	0.14	0.196	0.170	0.183
Lb (mean)	.386	0.900	.64	0.695	0.820	0.76	0.30	0.432	.375	0.40
Gizzard shad										
Number/15 min. sample	31.3	60.0	46.7	85.25	66.3	75.8	20.7	17.7	62.8	40.3
Kg (mean)	0.045	0.038	0.04	0.046	0.025	0.04	0.038	0.020	0.038	0.03
Lb (mean)	0.099	0.084	0.09	0.101	0.055	0.08	0.08	0.044	0.084	0.06

[1/] No electrofishing conducted in spring of 1979.

lity of catchable-size fish in the spring.

White crappie demonstrated a relatively small decrease in abundance over time (from an annual average of 0.71 fish per 15 minute sample in 1977 to 0.54 fish per 15 minute sample in 1980), and a more substantial decrease in average size [from 0.41 kg (0.9 lb) in 1971 to 0.18 kg (0.4 lb) in 1980].

Water quality studies

Although stratification may occur in late summer of some years, the shallow mean depth of the lake [7 m (23 ft)] and wind action act to limit the duration and intensity of stratification. Temperature and dissolved oxygen profiles were obtained by the ODWC on August 29, 1979 and September 5, 1980 from five stations representative of the major arms of the lake. Conductivity, pH and secchi determinations were also made at each station. A Hach-DR-EL analysis kit, a Garcia OPT/8500 and a Whitney underwater thermometer were used to collect water quality data. All water quality parameters measured were adequate to support fish life.

Analysis of the water quality data indicated that the lake was not thermally stratified in either year (Table 15). Less than a 2 degree C. (4 degree F.) difference was found between surface and bottom water temperature determinations in either year. There was only a slight difference between average pH values at the surface (8.8) and bottom (8.7) in 1979. In 1980, the average pH at the surface was 8.5 and 8.2 at the bottom.

Table 15. -- Eufaula Lake. Summary of water quality analyses conducted August 29, 1979 and September 5, 1980 from 5 stations*

	Station 1				Station 2				Station 3				Station 4				Station 5			
	Temp(c)		DO(mg/l)		Temp(c)		DO(mg/l)		Temp(c)		DO(mg/l)		Temp(c)		DO(mg/l)		Temp(c)		DO(mg/l)	
Depth (m)	1979	1980	1979	1980	1979	1980	1979	1980	1979	1980	1979	1980	1979	1980	1979	1980	1979	1980	1979	1980
Surface	27.5	27.8	7.5	6.0	27.9	27.2	7.3	6.0	28.5	27.2	8.2	6.0	28.1	27.8	6.9	6.0	28.8	27.8	7.7	6.0
2	27.5	26.7	7.5	5.0	27.8	26.7	7.1	5.8	27.9	26.7	7.1	5.8	28.0	26.1	6.8	5.8	28.4	26.1	7.4	5.5
4	27.5	26.1	7.2	4.1	27.5	26.1	7.0	4.8	27.9	26.1	7.1	4.8	27.8	25.6	6.8	5.1	28.2	25.6	7.3	4.2
6	27.5		7.1		27.5	26.1	6.9	4.5	27.5	26.1	5.8	4.5	27.5	25.6	6.7	4.9				
8	27.5		7.2		27.4	25.6	6.6	4.4	27.1	25.6	4.6	4.4	27.4	25.0	6.6	4.1				
10					27.2	25.6	6.1	4.2	26.9	25.6	4.2	4.2	27.1	25.0	5.6	4.3				
12					27.0	25.6	4.3	4.2	26.8	25.6	4.1	4.2	26.8		4.2					
14					26.6		3.6													
16					25.0		0.3													
Bottom	27.5	26.7	7.2	3.9	24.9	25.6	0.2	1.5	26.8	25.6	3.5	1.5	26.8	25.0	2.6	4.1	28.2	25.6	7.2	4.0

	1979	1980	1979	1980	1979	1980	1979	1980	1979	1980
Ave. conductivity (Micrombos/cm)	470	930	405	960	370	960	340	903	380	910
Ph										
Surface	8.8	8.5	87	85	9.2	8.5	8.8	8.5	8.6	8.3
Bottom	8.6	8.0	86	80	8.6	8.0	8.8	8.5	8.8	8.3
Secchi (in)	19	30	27	60	32	60	17	40	26	51

*Station 1 - Deep Fork Arm
Station 2 - North Canadian Arm
Station 3 - Central Pool
Station 4 - Gaines Creek Arm
Station 5 - South Canadian Arm

Turbidity was twice as great in 1979 [secchi average of 61.5 cm (24.2 in)] than in 1980 [average of 122.4 cm (48.2 in)]. Average conductivity was almost three times greater in 1980 (933 micromhos/cm) as in 1979 (393 micromhos/cm). The higher turbidity and lower conductivity exhibited in 1979 may be attributed to relatively greater rainfall and increased inflow to the lake experienced in 1979 as compared to 1980. For example, the inflow volume to Eufaula Lake was twice as high in the eight month period from January through August in 1979 [3.46 x $10^9 m^3$ (2,806,200 ac ft)] as in 1980 [1.75 x $10^9 m^3$ (1,416,888 ac ft)]. Tributary streams carried extensive silt loads under the flood stage conditions prevailing in 1979, which increased turbidity within the lake and, at the same time, diluted the concentration of ions responsible for the high conductivity values associated with normal or low stream flow conditions.

No provision was made to maintain a minimum instantaneous discharge from the lake. Water is discharged from Eufaula Lake only when generating power, passing flood waters or releasing water in excess of power production requirements. In actual practice, the daily (24 hour) average flow has exceeded 5.6 m^3/sec (200 cm ft/sec) only 70 percent of the time (James Randolph, Tulsa District, CE, pers. comm., 1981). Low dissolved oxygen concentrations have been recorded occasionally from the stilling basin below the dam, primarily when discharging from oxygen deficient lake strata in late summer (Table 16).

Although no catastrophic fish kills have been recorded in the stilling

Table 16. -- Summary of dissolved oxygen (mg/l) and temperature (c°) obtained in the generator stilling basin of Eufaula Lake in the summer and fall of 1980

Date	Approximate depth (m)*							
	0.9		4.6		7.6		10.6 (or max.)	
	Temp(c)	DO(mg/l)	Temp(c)	DO(mg/l)	Temp(c)	DO(mg/l)	Temp(c)	DO(mg/l)
7/31/80	24.8	1.47	24.6	1.45	24.4	1.46	24.1	1.53
8/21/80	26.9	4.63	26.8	3.88	--	--	26.5	3.70
8/25/80	23.8	1.83	21.7	0.66	21.7	0.93	21.7	1.07
9/5/80	25.8	2.23	22.1	0.18	22.0	0.24	21.9	0.14
9/15/80	22.8	0.21	22.0	0.23	22.0	0.29	22.0	0.56
10/8/80	22.6	3.90	22.1	2.55	22.1	2.32	22.0	2.29
10/27/80	19.2	6.95	19.1	6.58	19.0	6.80	18.7	6.93

*Extreme turbulence in the sample area precluded precise depth measurements.

e impoundment, several minor fish kills have occurred. Appa-
congregating in the stilling basin are usually able to mi-
grate porarily to downstream tailwater areas containing adequate
centrations during low dissolved oxygen stress periods with-
illing basin.

For the most part, water quality of the Canadian River below Eufaula Dam has been adequate to support fish life. A substantial sport fishery has developed in the Canadain River tailwater extending from the stilling basin as far downstream as the headwaters of the Robert S. Kerr Reservoir.

Angler survey

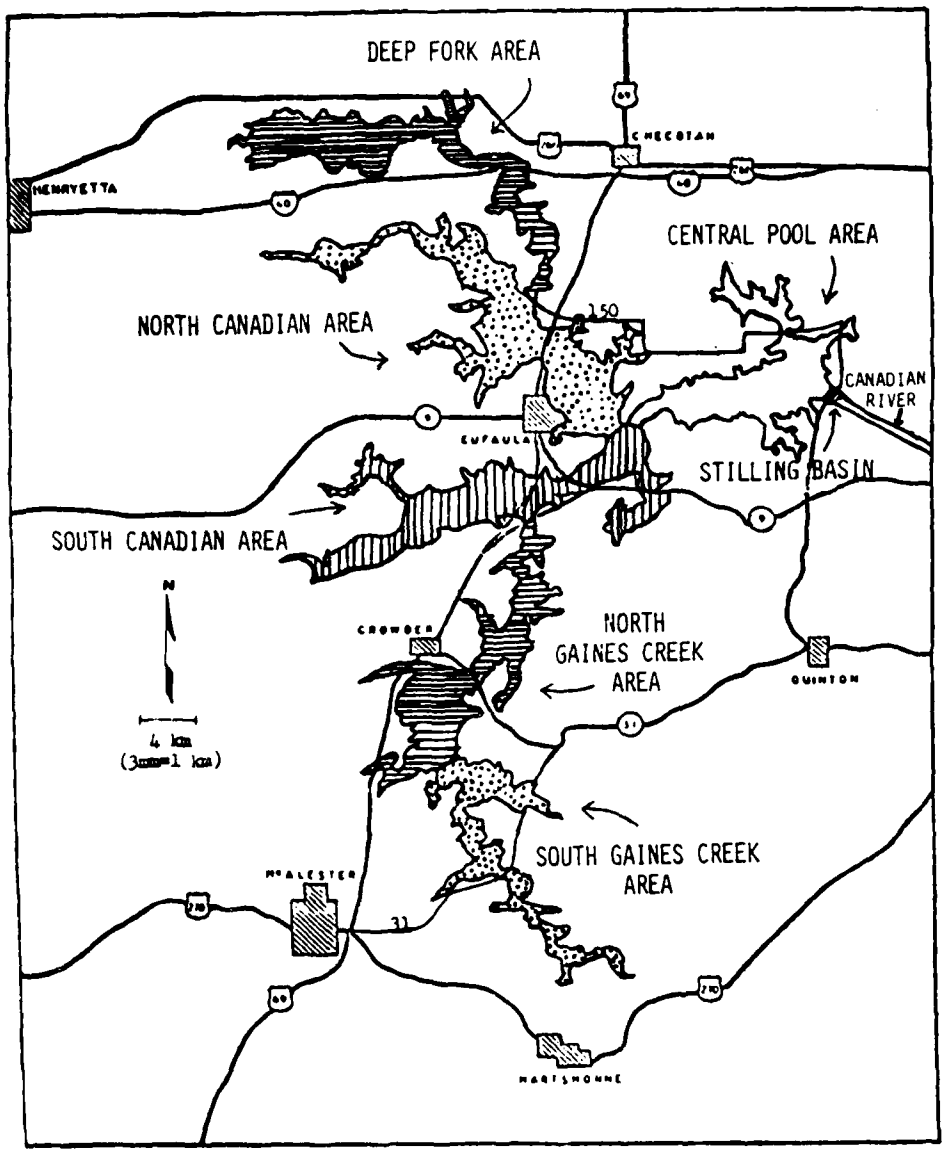
Data required to adequately describe the Eufaula Lake recreational fishery in a quantitative sense were not available prior to the current evaluation. A one-year study of the lake recreational fishery was conducted by the ODWC to acquire the necessary information upon which to base a realistic appraisal of the adequacy of the pre-construction planning documents. This study was designed and conducted by the ODWC from March 1, 1980 through February 28, 1981, under subcontract to SFI. The completion report for the study, submitted to SFI in July, 1981, comprised the primary informational source upon which the following section is based (6).

The angler survey designed by the ODWC involved a stratified random sampling scheme which essentially divided the year into seasons as well as weekdays vs. weekend days. The procedure used was described by the ODWC

in their report to SFI (op. cit.), viz:

> Creel interviews - Eight-hour roving creel surveys were conducted on Lake Eufaula from 1 March, 1980 through 28 February, 1981 (Figure 3). The major areas of the reservoir were: Deep Fork (5,451 ha), North Canadian (8,960 ha), South Canadian (7,885 ha), Central Pool (4,915 ha), and Gaines Creek (12,859 ha). The Gaines Creek area was split into North and South Gaines Creek, because the total area was too large to creel in an eight-hour day. Data from the two Gaines Creek creel areas were later combined for statistical purposes. Creel interviews were also conducted in an area that extended for one kilometer along either bank of the Tailwaters, or Stilling Basin (2 ha)...
>
> The year was divided into quarters according to season: spring, March-May; summer, June-August; autumn, September-November; and winter, December-February. Interviews were conducted on 192 days, or 48 days per quarter. The number of creel days was equally divided between weekdays and weekend days. The starting time for each creel day was randomly selected, with the restriction that all surveys were to end before sunset.
>
> The number of creel days spent in each creel area was an arbitrary decision, based upon the suspected amount of fishing pressure in each area. The number of creel days spent in each area per quarter was: Deep Fork-5, North Canadian-12, South Canadian-10, Central Pool-12, North Gaines Creek-2, South Gaines Creek-2, and Stilling Basin-5. The area to be creeled each day during the quarter was randomly selected. During an eight-hour creel day, two hours were spent in each of the four sub-areas, with the order varied randomly...
>
> Ninety-one percent of the interviews were conducted from a five meter boat. Because of windy conditions or cold weather, a truck was used the remaining 9% of the time... Data were recorded only if the party or individual had been fishing at least 15 minutes. One creel interview card was filled out for each party of anglers, regardless of the size of the party. Data recorded at each interview included location date, day-type (weekday or weekend day), fishing type (method), number of anglers

FIGURE 3. Lake Eufaula, Stilling Basin and the Canadian River, with seven creel areas



in the party, time spent fishing, whether the fishing trip was completed, species sought, total number of fish of any species returned, and the number and length (mm) of each fish in their possession.

In order to contact as many anglers as possible, the fish were not weighed. Most weight estimates were made later using species specific length-weight equations derived from standardized sampling data collected from Lake Eufaula during 1979 (27). If a particular species had not been sampled at Lake Eufaula during 1979, a statewide length-weight relationship was used (28).

Because only a small sample of anglers was needed for a rough estimate of nocturnal fishing pressure, 10% of the anglers interviewed were randomly selected for further questioning. They were asked if they night fished, and if so, how many times per year.

Pressure counts - To determine the number of anglers present during each quarter, 43 pressure counts were made from a Cessna 172 Skyhawk airplane. Flights were between three and four and one-half hours duration at an altitude of about 120 m. These flights were flown around the periphery of the reservoir and down the Canadian River to the headwaters of the R.S. Kerr Reservoir. The number of anglers (boat, bank, or tube) was recorded for each of the five major areas of the reservoir, the Stilling Basin, and the Canadian River.

Because fishing pressure was thought to be heaviest in the spring, the counts were stratified with 12 in the spring quarter, 11 in the summer quarter, 10 in the autumn quarter, and 10 in the winter quarter. Pressure counts dates were randomly selected to include two weekend days and two weekdays each month during the first quarter and at least two weekend days and one week day per month during the remaining three quarters. Other randomizations included the time of day, the starting point, and the direction of travel around the reservoir. The proportions of flight times resulting from this random selection were: a.m. weekday flights-21%; a.m. weekend flights-28%; p.m. weekday flights-12%; and p.m. weekend flights-37%.

A total of 316,508 angler-days involving 1,066,107 angler hours were estimated for the total project impact area over the period March 1, 1980 through February 28, 1981 (Table 17). Included in the total fishing effort were some 266,506 angler-days and 983,562 angler hours estimated for Eufaula Lake; 46,558 angler-days and 69,836 angler hours estimated for the Stilling Basin below the dam and 3,444 angler-days and 12,709 angler hours for the Canadian River tailwater downstream from the Stilling Basin to the headwaters of the Robert S. Kerr Reservoir.

Angling pressure estimates for Eufaula Lake included 231,744 angler-days and 855,290 angler hours, as estimated from the ODWC conducted daylight aerial creel survey, plus a separately estimated 34,762 angling trips and 128,272 angling hours which occurred at night. The estimated Eufaula Lake recreational fishery amounted to a total fishing pressure of 23.9 hrs/ha (9.7 hrs/ac).

It should be emphasized that the 1980-1981 ODWC daylight creel survey estimates represented only minimal values as the angling pressure estimates were derived solely from an aerial census. Consequently, the pressure estimates did not include an unknown (but substantial) amount of angling which occurs from some 700 covered private docks and two commercial docks located on the lake.

As indicated by angler interviews conducted during the daylight creel survey, the major portion of the angling effort at Eufaula Lake was specifically targetted for crappie (50.3 percent), black bass (18 percent),

Table 17. -- Eufaula Lake Project. Angling pressure statistics derived from aerial daylight census (43 flights) conducted by the ODWC on the project impact area from March 1, 1980 - February 28, 1981. [Estimates considered minimal as they do not include a substantial amount of angling conducted from approximately 700 covered private docks and 2 heated commercial docks located at the lake]

	No. angling man-days			No. angling hours			Mean trip length
	Total	No./ha (ac)		Total	No./ha (ac)		Hrs.
Eufaula Lake							
Daylight fishing							
Boat	150,445	3.7	(1.5)	608,381[1/]	14.8	(6)	4.0
Bank	81,299	2.0	(0.8)	246,909[1/]	6.0	(2.4)	3.0
Subtotal	231,744	5.7	(2.3)	855,290	20.8	(8.4)	3.69
Night fishing[3/]	34,762	0.8	34)	128,272	3.12	(1.3)	3.69
Total lake[3/]	266,506	6.5	)	983,562	23.9	(9.7)	3.69
Tailwater							
Stilling basin	46,558[2/]	23,279	(9,421)	69,836	34,918	(14,131)	1.5
Canadian river	3,444[2/]	--	--	12,709	--	--	3.69[2/]
Subtotal	50,002	--	--	82,545	--	--	1.65
Total project	316,508	--	--	1,066,107	--	--	--

[1/] Includes 338 hours of "tube" fishing.
[2/] Estimate of the number of angling man-days assumes the same average trip length of 3.69 hours as determined from daylight lake creel survey data.
[3/] Estimates of night fishing participation based on replies received from interviews conducted with approximately 10 percent of the total number of randomly selected anglers contacted during the daylight creel survey at Eufaula Lake.

and catfish (13.8 percent). Five percent of the angling effort was specifically directed to white bass. Only 0.07 percent of the anglers interviewed specified sunfish, and 0.02 percent carp, as target species. Anglers fishing for no particular species made up 12.1 percent of the total angling effort (Table 18).

Approximately 86 percent of the total number of fish harvested were creeled as target species including 97 percent of all crappie, 77 percent of all white bass, 69 percent of all black bass (primarily largemouth bass) and 54 percent of all catfish (primarily channel catfish and blue catfish).

The catch rate (no/hr) was much higher for fish specifically targetted by anglers (average of 0.735 fish/hr) as compared to only 0.105 fish/hr for incidentally creeled fish. The total estimated yield of fish from Eufaula Lake over the March 1, 1980 - February 28, 1981 creel survey period amounted to 15.6 fish/ha (6.3 ac) with a total weight of 4.7 kg/ha (4.2 lbs/ac). Crappie constituted 66 percent by number and 47 percent by weight of the total yield; catfish, 13 percent by number and 21 percent by weight; white bass, 12 percent by number and 15 percent by weight; and non-game species (carp, freshwater drum, smallmouth buffalo), 1 percent by number and 4 percent by weight. Bluegill, green sunfish, warmouth and other sunfish species made up only 1 percent by number and 0.38 percent by weight of the total yield (Table 19).

A comparison of the rate of harvest, yield and percentage [illegible]

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EVALUATION OF PLANNING FOR FISH AND WILDLIFE AT CORPS OF ENGINE--ETC(U)
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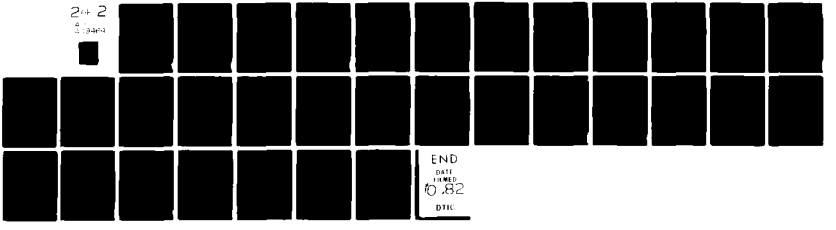

Table 18. -- Eufaula Lake. Comparison of angling pressure, rate of harvest and total harvest for species specified by anglers as a target species and as a non-target species

Target species	Percent of total hours fished	Fish harvested					No. fish/hr harvested		
		Target		Non-target					
	Target species	No.	%	No.	%	Total	Target	Non-target	Total
Black bass	18.0	28,457	69	12,613	31	41,070	0.1852	0.0147	0.048
Crappie	50.3	412,014	97	13,481	3	424,485	0.9569	0.0158	0.50
White bass	5.7	65,526	77	9,632	23	75,158	1.3514	0.0113	0.088
Catfish	13.8	44,857	54	38,926	46	83,783	0.3791	0.0455	0.10
Sunfish	0.07	1,072	13	7,142	87	8,214	1.6962	0.0084	0.01
Carp	0.02	313	19	1,330	81	1,643	1.4764	0.0016	0.002
Total	87.9[1]	552,239	86	90,096[2]	14	642,335[2]	0.7345	0.1053	0.75

[1] 12.1 percent of total angling pressure was not targeted for particular species.
[2] Includes freshwater drum, smallmouth buffalo and other species not specified as target species by any angler.

Table 19. -- Eufaula Lake Project. Summary of fish harvest statistic derived from an ODWC creel survey conducted at Eufaula Lake from March 1, 1980 through February 28, 1981. Total fishing pressure estimated at 855,290 hours [20.8 hrs/ha (8.4 hrs/ac)]

Species	Harvest rates			Yield				Percent composition		Average wt/fish	
	no./hr	kg/hr	lbs/hr	no./ha	no./ac	kg/ha	lbs/ac	No.	Wt.	kg	lbs
Largemouth bass	0.0420	0.027	0.06	0.88	0.36	0.57	0.51	5.61	12.0	0.65	1.4
Spotted bass	0.006	0.002	0.005	0.12	0.05	0.04	0.03	0.73	0.92	0.38	0.8
Subtotal black bass	0.048	0.029	0.065	1.00	0.41	0.61	0.54	6.34	12.92		
Crappie[1/]	0.497	0.106	0.234	10.27	4.16	2.21	1.97	66.30	46.67	0.21	0.5
White bass	0.088	0.034	0.074	1.83	0.74	0.70	0.62	11.72	14.81	0.38	0.8
Sunfish	0.009	tr.	tr.	0.20	0.08	0.02	0.02	1.29	0.38	0.09	0.2
Subtotal panfish	0.594	0.1403	0.309	12.30	4.98	2.93	2.61	79.31	61.86		
Channel catfish	0.0810	0.034	0.076	1.69	0.68	0.72	0.64	10.80	15.10	0.42	0.9
Blue catfish	0.016	0.012	0.027	0.33	0.13	0.26	0.23	2.12	5.50	0.78	1.7
Flathead catfish	0.001	tr.	tr.	0.02	0.01	0.01	0.01	0.16	0.24	0.43	1.0
Subtotal catfish	0.098	0.047	0.104	2.04	0.83	0.99	0.88	13.08	20.84		
Carp	0.002	.002	0.004	0.04	0.02	0.03	0.03	0.22	0.70	0.94	2.1
Drum	0.007	0.008	0.017	0.16	0.06	0.16	0.14	1.00	3.46	1.06	2.3
Smallmouth buffalo	tr.	tr.	tr.	tr.	tr.	0.01	0.01	0.05	0.22	1.21	2.7
Subtotal nongame fish	0.01	0.010	0.022	0.21	0.09	0.20	0.18	1.27	4.38		
Total	0.750	0.227	0.50	15.62	6.32	4.73	4.22	100	100	0.30	0.67

[1/] White crappie (99.2 percent); black crappie (0.8 percent).

of fish harvested from the stilling basin below Eufaula Lake with comparable values from Eufaula Lake is presented in (Table 20).

The 2 ha (5 ac) stilling basin provided an estimated 69,837 hours of recreational fishing [34,919 hrs/ha (14,131 hrs/ac)] and a total harvest of 414,479 fish weighing 19,416 kg (42,809 lb) amounting to a yield of 9,708 kg/ha (8,640 lb/ac). These values amounted to some 7.5 percent of the total project fishing pressure and 9.1 percent of the total weight of fish harvested from project waters.

Non-game species (carp, smallmouth buffalo and drum) comprised 43 percent of the total weight of fish harvested from the tailwater in contrast to less than 5 percent of the harvest from Eufaula Lake. The harvest of popular sport fish species (black bass and panfishes such as crappie and white bass) made up less than 12 percent of the weight of fish harvested from the stilling basin as compared to almost 75 percent of the total weight fish harvested from Eufaula Lake.

However, two popular sport fish species which were not found in Eufaula Lake (striped bass and sauger) were harvested from the tailwater. Striped bass made up 4.5 percent of total weight of fish harvested from the tailwater and sauger some 0.1 percent. Catfishes (channel catfish, blue catfish and flathead catfish) collectively comprised 40 percent of the total weight of fish harvested from the stilling basin as compared to only 21 percent in the Lake. The blue catfish was the most abundant species of catfish harvested from the tailwater and the channel catfish

Table 20. -- Eufaula Lake project. Comparison of pertinent creel survey statistics collected from Eufaula Lake and the stilling basin below the dam during the ODWC doncudted creel survey (March 1, 1980 through February 28, 1981)

	Yield				Average weight/fish				Rate of harvest (No. fish/hr)		% composition (wt)	
	Kg/ha		Lb/ac		Kg		Lb					
	Lake	Stilling basin	Lake	Stilling basin	Lake	Stilling basin	Lake	Stilling basin	Lake	Stilling basin	Lake	Stilling basin
Largemouth bass	0.57	27.0	0.51	24.0	0.65	0.24	1.4	0.5	0.042	0.032	12.0	0.3
Spotted bass	0.04	23.5	0.03	20.9	0.38	0.30	0.8	0.7	0.006	0.022	0.9	0.2
Subtotal black bass	0.61	50.5	0.54	44.9	-	-	-	-	0.048	0.054	12.9	0.5
Striped bass	-	431.4	-	383.9	-	1.41	-	3.1	-	0.01	-	4.5
Sauger	-	10.4	-	9.3	-	0.52	-	1.1	-	tr.	-	0.1
Subtotal	-	441.8	-	393.2	-	-	-	-	-	0.01	-	4.6
Crappie	2.21	316.4	1.97	281.6	0.21	0.15	0.5	0.3	0.497	0.06	46.7	3.3
White bass	0.70	735.4	0.62	654.5	0.38	0.28	0.8	0.6	0.088	0.07	14.8	7.6
Sunfish	0.02	-	0.02	-	0.09	-	0.2	-	0.009	-	0.4	-
Subtotal panfish	2.93	1051.8	2.61	936.1	-	-	-	-	0.594	0.13	61.9	10.9
Channel catfish	0.72	1014.9	0.64	903.3	0.42	0.26	0.9	0.6	0.081	0.11	15.1	10.4
Blue catfish	0.26	2888.2	0.23	2570.5	0.78	0.26	1.7	0.6	0.016	0.31	5.5	29.8
Flathead catfish	0.01	18.8	0.01	16.7	0.43	0.93	1.0	2.1	0.001	tr.	0.2	0.2
Subtotal catfish	0.99	3921.9	0.88	3490.5	-	-	-	-	0.098	0.42	20.8	40.4
Carp	0.03	2232.7	0.03	1987.1	0.94	2.23	2.1	4.9	0.002	0.03	0.7	23.0
Drum	0.16	588.5	0.14	523.8	1.06	1.07	2.3	2.4	0.007	0.02	3.5	6.0
Smallmouth buffalo	0.01	1421.0	0.01	1264.7	1.21	3.04	2.7	6.7	tr.	0.01	0.2	14.6
Subtotal non-game fish	0.20	4242.2	0.18	3775.6	-	-	-	-	0.01	.06	4.4	43.6
Total	4.73	9708.2	4.22	8640.3	0.30	0.44	0.67	0.97	0.75	0.64	100	100

	Eufaula Lake		Stilling basin		Total	
Surface area [ha (ac)]	41,070 (101,483)	99.99%	2 (5)	0.001%	41,072	(101,488)
Total number of hours fished	855,290	92.45%	69,837	7.5%	925,127	
Total weight of fish harvested (kg (lbs)]	194,261 (428,346)	90.9%	19,416 (42,809)	9.1%	213,677	(471,156)
Total number fish harvested	641,513	93.5%	44,439	6.5%	685,952	

was harvested most frequently from the lake.

Commercial fishery

In addition to the recreational fishery, a modest commercial fishery has developed on Eufaula Lake under the aegis of the ODWC. Commercial fishing licenses have been granted to some 19 individuals who are permitted to harvest non-game fish species utilizing 7.6 cm (3 in) bar mesh (or larger) gill and/or trammel nets (29, 30, 31, 32, 33).

Records maintained by the ODWC since July 1, 1976, indicate an annual average total harvest of approximately 100,722 kg (222,000 lbs) of fish, or some 2.5 kg/ha (2.2 lb/ac). The average annual monetary value of the commercial harvest was estimated at approximately $57,000 over the 5-year period of record (op. cit.). Buffalo (60 percent) and flathead catfish (27.2 percent) composed the major portion of the commercial harvest by weight (Table 21). Additional species harvested included gar (5.3 percent), carp (4.9 percent) and drum (2.6 percent). White bass and river carpsucker were harvested in insignificant numbers in some years.

There was no indication that the commercial harvest affected the fish community structure within Eufaula Lake. For example, the low annual level of harvest of commercial species, 2.5 kg/ha (2.2 lb/ac), represented only 1 percent of the average annual standing crop of these species as estimated by cove rotenone sampling. This extremely marginal rate of exploitation would not be expected to measurably affect the long-

Table 21. -- Eufaula Lake. Annual summary of the number, total weight and average size [kg (lbs)] of fish harvested commercially from July 1, 1976 through September 30, 1981

Year	Species Buffalo	Carp	Drum	Flathead catfish	Gar	River carpsucker	Total*
1976-77							
No.	22,718	2,302	1,267	7,958	677	263	35,185
Kg	75,337	5,508	3,383	35,317	2,278	319	122,142
Lb	166,117	12,146	7,459	77,874	5,024	703	269,323
Ave. wt	3.3 (7.3)	2.3 (5.3)	2.7 (5.9)	4.4 (9.8)	3.4 (7.4)	1.2 (2.7)	3.5 (7.7)
1977-78							
No.	22,205	3,917	1,598	7,370	2,602	30	37,725
Kg	63,952	8,455	4,201	28,413	12,081	86	117,194
Lb	141,015	18,643	9,264	62,650	26,638	190	258,413
Ave. wt	2.9 (6.4)	2.2 (4.8)	2.6 (5.8)	3.9 (8.5)	4.6 (10.2)	2.9 (6.3)	3.1 (6.8)
1978-79							
No.	16,189	1,292	409	5,543	469	-	23,902
Kg	32,395	2,215	1,074	18,646	1,659	-	55,988
Lb	71,431	4,883	2,368	41,114	3,657	-	123,453
Ave. wt	2.0 (4.4)	1.7 (3.8)	2.6 (5.8)	3.4 (7.4)	3.5 (7.8)	-	2.3 (5.2)
1979-80							
No.	15,875	1,362	1,190	6,659	1,315	-	26,423
Kg	48,511	3,093	2,825	23,775	413	-	82,354
Lb	106,966	6,820	6,230	52,424	9,101	-	181,590
Ave. wt	3.1 (6.7)	2.3 (5.0)	2.4 (5.2)	3.5 (7.9)	3.1 (6.9)	-	3.1 (6.9)
1980-81							
No.	27,470	1,401	649	7,141	1,686	-	38,356
Kg	81,136	5,396	1,806	30,810	6,782	-	125,934
Lb	178,904	11,899	3,982	67,937	14,954	-	277,685
Ave. wt	3.0 (6.5)	3.9 (8.5)	2.8 (6.1)	4.3 (9.5)	4.0 (8.9)	-	3.3 (7.2)
Ave. (1976-81)							
No.	20,891	2,055	1,023	6,934	1,350	-	32,318
Kg	60,266	4,933	2,658	27,392	5,385	-	100,722
Lb	132,887	10,878	5,861	60,400	11,875	-	222,093
Ave. wt	2.9 (6.4)	2.4 (5.3)	2.6 (5.7)	4.0 (8.7)	4.0 (8.8)	-	3.1 (6.9)
Ave. percent (wt)	60.0	4.9	2.6	27.2	5.3	-	100

*Includes 3 white bass weighing 5.9 kg (13 lbs) in 1977-78; 22 white bass weighing 22 kg (49 lbs) in 1979-80 and 9 white bass weighing 4 kg (9 lbs) in 1980-81.

term status of eigher the commercial or sport fish components of the total fish community within Eufaula Lake.

Fishery Resources -- Discussion of Planning Input

The first planning document pertinent to the fishery resources of the Eufaula Lake project was prepared by the FWS in January, 1950. This timely, comprehensive report appeared to adequately satisfy its major objectives; i.e. to provide the CE with a comparative assessment of fish and wildlife resource impacts anticipated by the construction of either the single reservoir Eufaula Lake project or an alternate proposal for construction of a two-reservoir system (Canadian and Onapa reservoirs) on tributary streams. However, the January, 1950 FWS report did not provide any specific recommendations for mitigation or enhancement of fishery resources associated with either of the development proposals under consideration.

The decision subsequently was made by the CE to proceed with the construction of the single reservoir Eufaula Lake project in the early 1950's and actual dam construction was initiated in 1956. Unfortunately, the FWS did not provide a formal evaluation nor offer recommendations for mitigating adverse impacts on fish and wildlife resources anticipated by the Eufaula Lake project until submission of the November 15, 1962 planning report, more than six years after the start of project construction and less than two years before completion. This unseemly and lengthy hiatus following initiation of project construction and the submission of the November, 1962 FWS report seriously reduced the cogency of the FWS recommendations pertinent to fishery resource mitigation and/or enhancement. Any FWS recommendation requiring substantial pro-

ject design changes and/or monetary expenditures obviously would appear to be inexpedient at this late date.

Proper implementation of the planning process requires early and continuing close cooperation between the natural resource agencies and construction agencies which apparently was lacking for this particular project.

However, aside from the late date of submission, the November 15, 1962 FWS report constituted a satisfactory planning document. The report provided the CE with a relevant appraisal of anticipated project impacts on fishery resources and presented recommendations appropriate for protecting and enhancing fish communities as well as angling opportunities at project waters. The first of these recommendations concerned protection of the tailwater fishery in the Canadian River below the dam. The FWS recommended implementation of a minimum instantaneous discharge of 5.6 m^3/sec (200 ft^3/sec) from the project to prevent downstream fish losses during prolonged periods of low flow.

The FWS estimated that the implementation of the minimum low flow recommendation would provide an additional 5,000 angler man-days valued at $5,000 annually over and above the number of angler man-days expected to occur in the tailwater without provision of a minimum flow requirement. As a further protective measure for the tailwater, the FWS suggested that the CE consider the incorporation of a Howell-Bunger type valve in the outlet to assure adequate quality of the water discharged from

the project.

Neither of these worthwhile FWS recommendations were given serious consideration by the CE. The reason for the refusal of the CE to consider the low flow recommendation was contained in an April 12, 1962 letter from the Tulsa District CE office addressed to the Chief of Technical Services, USFWS (9), as follows:

> Project plans do not include specific storage for maintaining minimum water releases to maintain the downstream fishery. Studies by this office indicate that minimum releases of 200 cfs as recommended would require approximately 150,000 acre feet of storage based on the most critical period of record. This storage, if taken from the power pool, would result in loss of power potential of $196,000 per year. If this amount of storage were taken from the flood control pool, it would result in the loss of potential flood control benefits of $250,000 per year.

The CE contention that approximately 150,000 acre feet of storage would be required to maintain a minimum flow of 200 cubic feet/sec based on the most critical period of record is, at best, misleading, and appears to be completely inappropriate to the actual situation. For example, as it requires slightly less than 2 acre feet (1.98 ac ft) of storage per day to provide a flow of 1 cfs, the 150,000 acre feet prescribed by the CE would provide a flow of 200 cubic feet/sec for over a full year (375 days)! The fact that the project was authorized and designed to provide for hydropower generation and flood control, and thus would be frequently releasing large quantities of water far in excess of the recommended 200 cubic feet/sec, provides further evidence that the con-

tention of CE was illogical and untenable.

However, the FWS evidently accepted the CE statement at face value, as there was no indication that the FWS further contested the CE's position in this matter. It was unfortunate that neither the CE nor the FWS indicated any willingness for further negotiation in order to arrive at mutually acceptable minimum instantaneous flow value.

Post-impoundment findings indicated that dissolved oxygen values in t stilling basin dropped to dangerously low levels on occasion. Low dissolved oxygen values were encountered during protracted periods of zero discharge from the lake and/or during the late summer and fall lake stratification period when dissolved oxygen values in the lake strata near the discharge ports approached zero. The intake for the discharge facility at Lake Eufaula was located deep in the hypolimnium at elevation 154 m (506 ft), some 24 m (79 ft) below the normal power pool surface elevation. Apparently seepage through the dam [estimated at 2 m^3/sec (70 cfs)] has provided some measure of protection for fish in the stilling basin during low discharge periods.

The second FWS recommendation was offered in anticipation of the possible future need to control the abundance of non-game species in the lake. This recommendation called for the development of 10 strategically located seining areas within the lake basin. Fences, brush and other potential obstructions were to be removed from these areas prior to impoundment in order to facilitate post-impoundment seining operations to be

conducted by commercial fishermen. Apparently this recommendation was accepted by the CE. Ten appropriate locations for the establishment of seining areas were selected by the CE in cooperation with OSWC personnel (34), viz:

> The tentative clearing plan for Eufaula Reservoir was coordinated with the Oklahoma Department of Wildlife Conservation. A meeting was held in the Tulsa District Office with personnel from that department, in which their concurrence in the proposed plan of their recommendations for seining areas were received. Ten seining areas were selected in accordance with these recommendations. The uncleared portions of the reservoir will provide areas for concentrating fish populations and use by the visiting public for fishing. Their approval of these areas is indicated in letter dated 17 May, 1960, a copy of which is contained in Exhibit A. When plans and specifications for clearing are prepared, it is proposed to further coordinate the plans with that agency to obtain concurrence and designation of certain small coves within the proposed clearing area to be left uncleared.

However, there is no record of post-impoundment use of these areas by commercial fishermen. Commercial fishermen at Lake Eufaula currently are restricted to the use of gill and trammel nets.

The third fishery resource oriented FWS recommendation called for the construction by the CE of a parking area below the dam and a fishing platform to enable anglers to safely take full advantage of the tailwater fishery. The cost of the proposed fishing platform was estimated by the FWS at $10,000. Although the CE subsequently provided a parking area below the dam, the fishing platform was not constructed.

The fourth FWS recommendation stipulated that timber clearing within the lake basin be held to a minimum. This recommendation was followed closely by the CE. Standing timber was left in selected cove areas to serve as fish attractors. Such areas have proven to be popular areas for recreational fishing.

The remaining recommendations contained in the November 15, 1962 FWS report addressed standard institutional practices, all of which have since been implemented. They included the recommendation that project waters be made available to the ODWC for fishery management purposes, and that parking and boat launching facilities be developed at all recreation areas adjoining the lake.

Recreational man-day use predictions contained in the November 15, 1962 FWS report considerably under-estimated the actual extent of the post-impoundment fishery both in Eufaula Lake and the Canadian River tailwater below the dam. Post-impoundment recreational angling man-day use documented for the total project impact area was more than 2.5 times greater than predicted by the FWS (Table 22). The number of recreational angler man-days, as estimated during the 1980-81 ODWC conducted aerial angler survey at Eufaula Lake (266,506 man-days), was more than 2.3 times greater than predicted by the FWS in the November 15, 1962 planning report (113,000 man-days). Post-impoundment man-day use in the tailwater (including the stilling basin and Canadian River) as estimated during the 1980-81 creel survey (50,082 man-days) was more than 4 times

Table 22. -- Eufaula Lake project. Comparison of predictions of recreational angling man-day use and commercial fish harvest within the project impact area as contained in the November 15, 1962 FWS report with documented post-project occurrences

Location	FWS predictions			Post-project observations			Difference				
	Rec. fishery	Comm. fishery		Rec. fishery	Comm. fishery		Rec. fishery		Comm. fishery		
	No. man-days	kg	(lbs)	No. man-day	kg	(lbs)	No. man-days	% change	kg	lbs	% change
Eufaula Lake	113,000	317,460	(700,000)	266,506	100,722	(222,093)	-153,506	+136	-216,738	477,907	-68
Tailwater											
Stilling basin	N.A.	N.A.		46,558	N.A.		N.A.	N.A.	N.A.	N.A.	N.A.
Canadian River	N.A.	N.A.		3,444	N.A.		N.A.	N.A.	N.A.	N.A.	.A.
Subtotal tailwater	12,000	N.A.		50,002	N.A.		-38,002	+317	N.A.	N.A.	N.A.
Total project	125,000	317,460	(700,000)	316,508	100,722	(222,093)	-191,508	+153	-216,738	-477,907	-68

N.A. - Not applicable.

greater than predicted by the FWS.

FWS predictions of the extent of the post-impoundment Eufaula Lake commercial fishery, on the other hand, were considerably exaggerated. The documented post-impoundment commercial fish harvest [an annual average of 100,722 kg (222,093 lbs) from July 1, 1976 through September 30, 1981] was less than one-third of the 317,460 kg (700,000 lbs) predicted by the FWS.

Overall, the construction of the Eufaula Lake project greatly increased recreational angling opportunity with the areas of project influence. Documented post-impoundment angling man-day use at Eufaula Lake and tailwater (316,508 man-days) was more than 2,100 percent greater than the FWS estimate of 14,000 angling man-days per year without the project.

SUMMARY

Eufaula Dam is located in eastern Oklahoma at river mile 27 on the Canadian River approximately 19 km (12 mi) east of Eufaula and 50 km (31 mi) south of Muskogee, Oklahoma. Major cities within 161 km (100 mi) of the project include Tulsa and Oklahoma City, Oklahoma and Fort Smith, Arkansas. Eufaula Lake, the largest body of water in Oklahoma, extends into McIntosh, Haskell, Pittsburg, and Okmulgee counties, Oklahoma at average power pool elevation. The population of the four-county area was 102,300 in the 1980 census.

Eufaula Dam and Reservoir was authorized by the River and Harbor Act approved July 24, 1946 (Public Law No. 525, 79th Congress, 2nd Session), for flood control hydropower production, navigation, water supply and fish and wildlife. Authority for the administration of lands and water areas is contained in Section 4 of the Flood Control Act approved December 22, 1944 (58 Stat. 889), and by Section 4 of the Flood Control Act of 1946 (60 Stat. 642) as further amended by Section 209 of the Flood Control Act of 1954. Development at the lake is governed by provisions of the Federal Water Project Recreation Act of 1965 (PL 89-72).

Construction of the dam was initiated in December, 1956, and final closure was made for flood control in February, 1964. The dam is a combination concrete and earthen structure approximately 97.5 m (114 ft) above the main channel of the Canadian River.

The terrain in the Eufaula Lake region consists of flat to gently rolling valley lands bordered by steeply rolling to semi-mountaneous areas. Major river valleys are generally broad, but narrow restricted reaches occur in the more rugged hilly areas. The valleys of the smaller tributaries are V-shaped and narrow. Tributary streams are heavily silted with unstable bottom structures.

Much of the land in the vicinity of the lake is devoted to agriculture, particularly livestock production, or has been subdivided for home sites for year-round or seasonal occupancy. The limited wooded areas near the lake are primarily mixed bottomland hardwoods (cottonwood, willow, sycamore, ash, elm, hackberry, pecan, and flood-tolerant oaks) and upland hardwoods such as post oak, red oak, white oak, blackjack oak and hickory interspersed with short leaf pine.

At full power pool, Eufaula Lake inundates 41,360 ha (102,200 ac) extending upstream from the dam on the Canadian River and three tributary streams (North Canadain River, Deep Fork River and Gaines Creek). The lake covers 58,155 ha (143,700 ac) at the top of the flood control pool, elevation 178 m (585 ft). A total of 74,167 ha (183,264 ac) were acquired for the project, including 62,076 ha (153,387 ac) by fee simple title and the remaining 12,091 ha (19,877 ac) by flowage easement. Project lands acquired above the power pool total some 20,715 ha (51,187 ac) extending in a narrow band around the highly convoluted 965 km (600 mi) lake shoreline.

Two separate reports were prepared by the FWS which described pre-project conditions and contained predictions of post-impoundment impacts on fish and wildlife resources pertinent to the Eufaula Lake project. The first relevant FWS report, dated January, 1950, was prepared in response to a 1948 CE request for a comparative evaluation of impacts on fish and wildlife resources anticipated from the construction of a single large reservoir on the Canadian River (the Eufaula Lake project) and an alternate proposal involving the construction of two smaller reservoirs on tributary streams (the Canadian/Onapa project).

This initial FWS report provided the CE with a timely and comprehensive assessment of the impacts of fish and wildlife resources to be expected by construction of either of the proposed development projects. The monetary value of the wildlife resources associated with the proposed construction of the Eufaula project was predicted to decline by $19,000 per year as a result of the loss or impairment of terrestrial wildlife habitat within the 82,559 ha (204,000 ac) project impact area. This wildlife resource loss was expected to be offset by a predicted increase in the monetary value of project associated fishery resources of some $202,000 per year. Increased fishery resource values were attributed to the recreational fishery expected to develop in the proposed 35,859 ha (89,000 ac) Eufaula Lake and tailwater. Thus, the construction of the Eufaula project was expected to result in an overall net annual increase in combined fish and wildlife values of some $183,000.

A smaller ($65,400) increase in the net monetary value of combined fish and wildlife resources was predicted with development of the alternate Canadian/Onapa project. The anticipated increase in post-construction fishery resource value ($66,000) associated with development of the two-reservoir system [combined surface area of 21,490 ha (53,100 ac)] more than offset the minor ($600) loss of wildlife resources expected to occur within the 75,487 ha (186,525 ac) project impact area. Substantial upland game resource losses at the combined Canadian/Onapa project were counter-balanced by the enhancement of waterfowl resources expected to develop at the Onapa Reservoir.

Several general suggestions appropriate for mitigating anticipated fish and wildlife losses were advanced by the FWS, including granting agricultural leases to enhance upland game habitat, developing a National Wildlife Refuge for waterfowl enhancement and providing for minimum instantaneous discharge flows at the reservoir tailwaters. The 1950 FWS report emphasized the importance of maintaining the integrity of each of the various wildlife groups without sacrificing one resource for the gain of another.

A decision subsequently was reached by the CE to proceed with the development of the Eufaula Lake project in lieu of the combined Canadian/Onapa Reservoir complex. The November 15, 1962 FWS letter-report, addressed to the District Engineer, Corps of Engineer, U.S. Army, Tulsa, Oklahoma, constituted the final FWS assessment of fish and wildlife

resources associated with the construction of the Eufaula Lake project. The report was reviewed and endorsed by the CSWC.

Much of the baseline information presented in the initial 1950 FWS planning report which dealt specifically with the Eufaula Lake project was incorporated in the 1962 FWS report. The only substantial design change made by the CE for the Eufaula Lake project in the interim between submission of the January, 1950 and the November 15, 1962 planning reports was a proposed increase in the size of the reservoir at full power pool from 36,018 ha (89,000 ac) to 41,461 ha (102,500 ac). The subsequent establishment of white-tailed deer within the project impact area was the only major change in the wildlife resource fauna noted. No interim changes occurred in the fish fauna.

The FWS predicted that substantial losses of upland game and big game habitat would occur with the project in place. Approximately 63,538 ha (157,000 ac) of habitat, amounting to some 75 percent of the total project impact area of 85,291 ha (210,750 ac) would be lost as a result of impoundment or otherwise adversely affected by project construction.

As a consequence, hunting effort for upland game species was predicted to decline some 84 percent (from 10,000 man-days per year without the project to 1,700 with the project in place), and hunting for white-tailed deer was predicted to decline from 200 man-days per year without the project to insignificance with the project in place. Hunting man-day use for waterfowl was expected to increase over four-fold after impound-

ment (2,500 man-days per year compared to only 560 man-days per year without the project).

As a result of the restrictive land acquisition policy adopted by the CE for the Eufaula Lake project, post-impoundment wildlife habitat is extremely limited and poorly situated for efficient management. Much of the project land available for wildlife habitat development is situated in narrow, often discontinuous, strips around the lake periphery.

Although the ODWC continuously exercised statutory responsibilities for wildlife resource regulation enforcement on project lands following impoundment of Eufaula Lake in 1964, no on-the-ground wildlife habitat management was undertaken by the state until the execution of a formal license agreement with the CE on January 1, 1973. The license agreement provided for the establishment of five wildlife management units to be managed by the ODWC comprising a total of 12,900 ha (31,875 ac), including 6,475 ha (16,000 ac) of terrestrial habitat and 6,425 ha (15,875 ac) of water. In 1979, the ODWC initiated negotiations with the CE to amend the 1973 license agreement in order to expand wildlife management holdings. A new license was executed effective January 1, 1981 which provided the ODWC with six wildlife management units with a total area of 19,165 ha (48,469 ac) including 8,481 ha (20,956 ac) of terrestrial habitat and 11,235 ha (27,513 ac) of water area.

Wildlife habitat quality was considered poor and wildlife population minimal on most of the areas initially leased to the ODWC as a result of

severe overgrazing fostered by landowners prior to purchase by the CE. By the end of the first six years (1974-1980), the ODWC had installed 48 km (30 mi) of fencing to mark property lines and control livestock trespass which substantially alleviated the overgrazing problems on ODWC leased lands.

With impetus provided by years of continuous pressure from the ODWC, FWS and private conservation organizations, the CE finally initiated a long-range fencing program in 1979 to enhance wildlife habitat quality on remaining project lands. In addition to implementing an accelerated boundary line fencing program to benefit wildlife, the CE is currently cooperating with the ODWC in developing a long-term water level manipulation plan for Eufaula Lake designed to enhance fishery and waterfowl resources.

Earth-filled dikes have been constructed by the ODWC which permitted impoundment of some 283 ha (700 ac) of green tree and emergent vegetation marshes as waterfowl feeding and resting areas. Also, ODWC project personnel have planted an average of 81 ha (200 ac) of food plots annually (primarily wheat, milo and sunflower) for upland wildlife species. In addition, the ODWC negotiated and supervised sharecrop agreements with cooperators on 607 ha (1,500 ac) which provided additional food for upland game and waterfowl. These agreements stipulated that a percentage of the crops planted be left unharvested for wildlife.

Prior to project construction, the 483 km (300 mi) of stream located within the project impact area supported only meagre fish communities as a result of unstable bottom strata, turbidity and chronic pollution from oil field brine wastes, mining and domestic sewage. However, post-impoundment water quality within Eufaula Lake and the Canadian River tailwater was expected to be adequate to support a productive and diversified warmwater fish community, including both sport fish species such as largemouth bass, white bass, crappie, catfishes, and non-game fish species such as drum, carp and buffalo. Recreational fishing man-day use was predicted to increase from 14,000 man-days per year without the project to 125,000 man-days per year with the project in place. The commercial fish harvest was predicted to increase from an annual average of 78,000 kg (172,000 lbs) without the project to 317,460 kg (700,000 lbs) with the project in place.

ODWC estimates of standing fish crops developed annually in 1972, 1977, 1979, and 1980 indicated that Eufaula Lake supported a rich and diverse fish community typical of other large reservoirs located within the same watershed. Gizzard shad and other non-game species (primarily carp, drum, smallmouth buffalo, and river carpsucker) collectively comprised the major portion of the estimated fish community standing crop in each of the four years that cove rotenone sampling was conducted. The most popular recreational fish species (black bass, crappie, white bass, catfish and sunfish) averaged less than twenty percent of the average standing fish crop over the four year sampling period. No readily discernable

temporal trend in abundance of any particular species was apparent from the data. Successful reproduction by all sport fish and prey species occurred each year.

Electrofishing samples were collected by the ODWC during the spring and fall months each year from 1977 through 1980. Largemouth and spotted bass exhibited little change in abundance over the four-year sampling period, although both species registered slight gains in abundance in 1980. The mean size of both species was smaller in samples collected in the fall as compared to spring collections, suggesting high angling mortality of catchable-size fish in the spring.

Water quality studies conducted in 1979 and 1980 indicated that the shallow mean depth of the lake [7 m (23 ft)] and wind action act to limit the duration and intensity of stratification which occurs periodically in the summer and fall. All water quality parameters measured were adequate to support fish life.

Water is discharged from Eufaula Lake only when generating power, passing flood waters or releasing water in excess of power production requirements. No provision was made by the CE to maintain a minimum instantaneous discharge from the lake. The daily (24 hour) average flow has exceeded 5.6 m^3/sec (200 cu ft/sec) only 70 percent of the time. Low dissolved oxygen concentrations have been recorded occasionally from the stilling basin below the dam, primarily when discharging from oxygen deficient lake strata in late summer.

Although no catastrophic fish kills have been recorded in the stilling basin since impoundment, several minor fish kills have occurred. Apparently fish congregating in the stilling basin usually are able to migrate temporarily to downstream tailwater areas containing adequate oxygen concentrations during low dissolved oxygen stress periods within the stilling basin.

For the most part, water quality of the Canadian River below Eufaula Dam has been adequate to support fish life. A substantial sport fishery was developed in the Canadian River tailwater, extending from the stilling basin as far downstream as the headwaters of the Robert S. Kerr Reservoir.

The November 15, 1962 FWS report presented a series of well conceived recommendations designed to assure optimum utilization of project associated fish and wildlife resources. FWS recommendations pertinent to mitigation of predicted wildlife resource loss included provision for (1) development of a zoning plan in concert with the ODWC that would provide adequate areas within project boundaries for hunting; (2) that all such areas be clearly marked to assure free public access; (3) that approximately 5,197 ha (12,841 ac) of land located outside the approved project purchase boundary be acquired in fee title at project cost and, together with other incidentally acquired project lands located within the approved purchase boundary [some 6,475 ha (16,000 ac)], be licensed to the ODWC for wildlife management purposes; and (4) that these designated wildlife management areas be fenced and developed initially at project expense.

Fishery resource oriented recommendation called for: (1) a minimum instantaneous release of 3.6 m^3/sec (200 ft^3/sec) to the Canadian River tailwater below the dam; (2) that 10 areas within the lake basin be cleared of obstruction and designated as seining areas to permit the harvest of non-game fishes after impoundment; (3) construction of parking facilities and a fishing platform (estimated cost of $10,000) to enhance angler access to the reservoir tailwater; (4) that standing timber be left in appropriate areas of the reservoir to serve as fish attractants; and (5) that boat launching ramps be provided at all parking and recreation areas adjoining the reservoir.

It was evident that the CE did not give serious consideration of implementing any of the November 15, 1962 FWS report recommendations that entitled monetary expenditures and/or substantial alteration of previously established project design parameters.

The failure of the CE to implement the FWS recommendation for the purchase of lands outside the established purchase boundary specifically for wildlife resource mitigation provides a case in point. The importance of this FWS recommendation was underscored by the fact that the fee purchase boundary for the Eufaula project was only 1 m (3 ft) above the top of the flood control pool. As a consequence of this restrictive land acquisition policy (so-called Eisenhower policy), only a narrow strip of land peripheral to the lake was obtained. These holdings offered only minimal potential for wildlife resource development.

Other similar examples include the failure of the CE to consider FWS recommendations for provision of an instantaneous minimum flow below the project, the failure to develop a fishing platform in the tailwater, and the failure to provide funding for fencing and initial development of project lands subsequently leased to the ODWC as wildlife management areas.

On the other hand, the CE was quick to implement FWS recommendations which did not conflict with existing CE policies and project design parameters, such as provision of hunter and angler access facilities, reservoir zoning policies and negotiation of lease agreements to provide for ODWC management of project lands acquired incidental to other project objectives.

The cardinal reasons for the lack of CE flexibility for accommodating FWS recommendations appeared to be associated (in large measure) with the tardiness of the FWS report submission and the apparent lack of early and continuing coordination between the two agencies. Unfortunately, the FWS did not provide a formal evaluation nor offer recommendations for mitigating adverse impacts on fish and wildlife resources anticipated by the Eufaula Lake project until submission of the November 15, 1962 planning report, more than six years after the start of project construction and less than two years before completion. This unseemly and lengthy hiatus following initiation of project construction and the submission of the November, 1962 FWS report seriously reduced the cogency of the

FWS recommendations pertinent to fish and wildlife resource mitigation and/or enhancement. Any FWS recommendation requiring substantial project design changes and/or monetary expenditures obviously would appear to be of doubtful expediency at this late date. Proper implementation of the planning process requires early and continuing close cooperation between the natural resource agencies and construction agencies which apparently was lacking for this particular project.

The accuracy of FWS predictions of post-impoundment hunter and angler man-day use proved highly variable. Post-impoundment hunting man-day use for white-tailed deer was much greater than predicted. FWS prediction of post-impoundment hunting effort for upland game and waterfowl were reasonably on target. Based on post-impoundment hunting man-day use estimates developed by the ODWC for licensed lands, it seems likely that full implementation of the mitigation plan proposed by the FWS in the November 15, 1962 planning report would have substantially mitigated predicted project occasioned wildlife resource losses.

Recreational man-day use predictions contained in the November 15, 1962 FWS report considerably under-estimated the actual extent of the post-impoundment fishery both in Eufaula Lake and the Canadian River tailwater below the dam. Post-impoundment recreational angling man-day use documented for the total project impact area was more than 2.5 times greater than predicted by the FWS. FWS predictions of the extent of the post-impoundment Eufaula Lake commercial fishery, on the other hand,

were considerably exaggerated. The documented post-impoundment commercial fish harvest [an annual average of 100,722 kg (222,093 lbs) from July 1, 1976 through September 30, 1981] was less than one-third of the 317,460 kg (700,000 lbs) predicted by the FWS.

Overall, the construction of the Eufaula Lake project greatly increased recreational angling opportunity within the area of project influence. Documented post-impoundment angling man-day use at Eufaula Lake and tailwater (316,500 man-days) was more than 2,100 percent greater than the FWS estimate of 14,000 angling man-days per year without the project.

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